SCIENCE

FRIDAY, MARCH 27, 1914

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

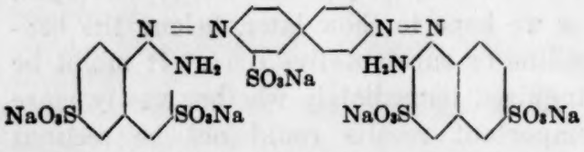
THE ACTION OF VITAL STAINS BELONGING TO THE BENZIDINE GROUP[1]

THE brilliant advances in our knowledge of the chemistry of aniline dyes, brought about naturally by the enormous commercial importance which the dyes possess, has been brought to bear, and will in the future be brought to bear, we believe, in the solution of some important problems in biology. The dyes possess peculiar advantages; especially is this true in the case of those of them which undergo little or no chemical transformation when injected into the living body. To this class of dyes, as we hope to show later, belong the benzidine or substantative dyes. It might be inquired immediately whether vastly more important results could not be secured from the study of dyes which, on the contrary, are known to suffer definite chemical changes within the body, for it might be supposed, for instance, that valuable light could be thrown on oxidative or reductive processes peculiar to certain cells or tissues. It was, of course, with motives not far removed from these, that Ehrlich first seriously attempted the use of dyes to solve the problem of the relation between pharmacological action and chemical constitution in his classical essay on this thesis in 1902. When we insist, however,

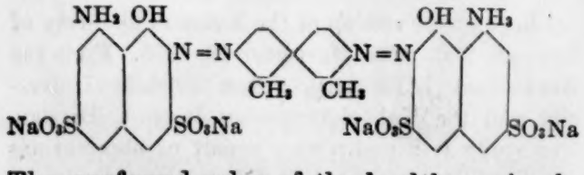
[1] Read at the session of the National Academy of Sciences, Baltimore, November 18, 1913. From the Anatomical Laboratory, Johns Hopkins University and the Kgl. chirurgisches Institut, Breslau. The study is a preliminary report of observations which will be presented in full in the Memoirs of the Rockefeller Institute for Medical Research and which were rendered possible by grants from the Rockefeller Institute and the Robert Koch Stiftung, Berlin.

that the study of dyes which suffer no chemical change within the body is of the highest value and indeed calculated to lead us to results which can be secured in no other way, we do so mainly because the class of dyes to which we refer can be injected in relatively large quantities into the blood stream of living animals without perceptible toxic effect; and the dye, taken care of as it were by definite cells which store it unchanged within their cytoplasm, can be detected without difficulty, wherever it may be, on account of its color.

In 1905, Ehrlich and Shiga, then attempting the cure of trypanosome infections in laboratory animals, happened to find that the azo dye, which they named trypan red and which possesses the following formula:



could be injected in sufficient quantity into the living animal to kill the organisms of the disease without perceptible toxic effect to the cells or tissues of the host, themselves deeply stained. A year later, driven thither in the same quest, Nicolle and Mesnil, of Paris, discovered a similar effective compound or "good color" as they called it in trypan blue, a dye formed by the combination of two molecules of 1.8 amidonaphtol 3.6 disulphonic acid with one molecule of diazotized ortho-tolidine in alkaline solution.



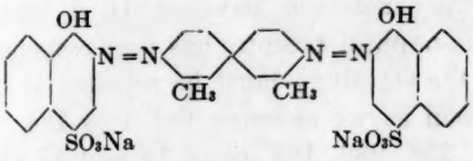
The profound color of the healthy animals which received this dye could not fail to attract the attention of Nicolle and Mesnil, who set Boufard the fascinating problem of determining in what form the dye persisted in the body. His report, which was all too short, nevertheless acquainted us with the main fact that the dye had not merely remained in the fluids of the body or had pervaded the organs and tissues in a profuse way, but was engulfed in the bodies of certain definite cells primarily of one type which we shall have occasion to describe carefully shortly. Coincidently Goldman at Ehrlich's suggestion took up the same theme, and his enthusiastic studies have in spite of occasional inaccuracy attracted general interest to the subject.

Nowhere however in the rapid literature which has begun to accumulate on this subject can one find an attempted answer to the fundamental question of how the dye really acts on the cells of the body, *i. e.*, what property it is by virtue of which one of the members of this class of dyes is enabled to be a brilliant vital stain; whereas a closely related dye is a complete failure. Nor, secondly, does it seem to me that full advantage has been taken of the great opportunity bestowed by these dyes in enabling us to detect a hitherto unknown or unrecognized function of a great mass of cells all over the body which can now be grouped together under a common designation as a great system or tissue.

If we inject into the peritoneal cavity of a mouse 1 c.c. of a one half per cent. solution of trypan blue, we can observe within a few minutes that the ears, the tip of the nose, the tail, the mucous membranes and soon the skin of the entire body have begun to blue, and that this deepens rapidly in intensity, so that within a few hours a maximal deep blue color is possessed by the animal, a color which, in spite of this single dose, is not lost for many weeks. The animal thus stained plays, eats, breeds, and in all ways manifests its normal activity, and

there is no evidence of the ill effect of the dye.

If now instead of trypan blue we employ the brilliant blue dye azo-blue whose constitution is



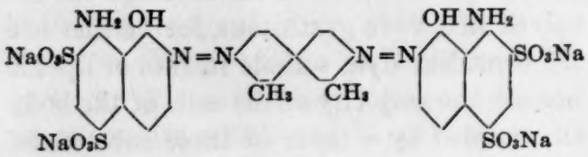
we are met by a striking difference. Neither within minutes or hours after the intraperitoneal injection of such a dye is any trace of color to be seen from the dye, and the repeated injection of the dye over a long period of time does not in any way change this negative result. The autopsy of such an animal shows indeed that we have heaped upon it a large quantity of a colored foreign body, for the dye has remained on the whole where it was injected, that is, in the peritoneum and the structures connected with it. Why this difference?

Several notions have been advanced in explanation of the action of vital stains. Primarily we have to do with the ideas, first, that a chemical union exists between the dye molecules and some portion of the cell protoplasm, and, second, the theory that dyes owe their ability to stain vitally to some physical property by virtue of which they can penetrate the cell. The name of Ehrlich is connected with the first of these two views, while that of Overton is identified with the second, and we may mention here that the commonest physical rather than chemical explanation of vital staining has been that the dyes in question are soluble in fat or fat-like bodies, a layer of which was assumed to envelop the cell. While this explanation may have been convincing in the explanation of vital staining obtained by the earliest known vital stains (methylene blue and neutral red) we are aware now that both of the assumptions involved in it were gratuitous, for neither are the benzidine dyes soluble in fats or lipoids nor are the majority of the cells of the body surrounded by a layer of these substances. If, then, in spite of the above, we must maintain that after all physical factors play a predominant rôle in the vital staining produced by the azo or benzidine dyes, it is for reasons quite apart from those involved in Overton's lipoid theory.

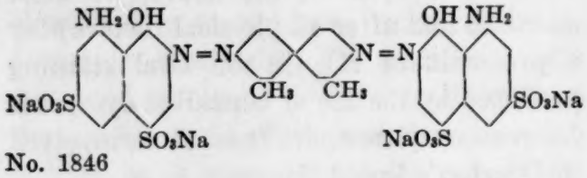
The chemical explanation of a vital stain presupposes that there exists between some element of the protoplasm of the cell, the chemo-receptor in the sense of Ehrlich, and some part of the dye molecule a combination, such as we are accustomed to see take place between two bodies in accordance with the laws of formal valence. It is only necessary to show how important such an explanation is in the mind of Ehrlich by mentioning the fact that he assigns the therapeutic effects of the drug salvarsan primarily to an affinity which he assumes to exist between the parasites of syphilis and a precise part of the salvarsan molecule; namely, the ortho-amido-phenol configuration. The application of this principle in an explanation of the vital stain produced by trypan blue must lead us to maintain that a similar configuration, *i. e.*, the peri-amido-naphtol configuration, is really responsible for the union between dye and cell which gives us the vital stain here. We can dispense with such reasoning shortly.

Evidence which would appear to concern the efficacy of a peri-amido-naphtol ceptor is furnished by the brilliant vital staining produced by the dyes Nos. 1824, 1835 and 1846, in all of which the hydroxyl and amido groups are in a peri position to one another, and the azo bond at position II.

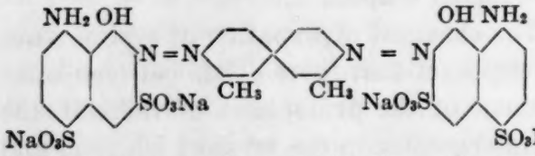
No. 1824



No. 1835

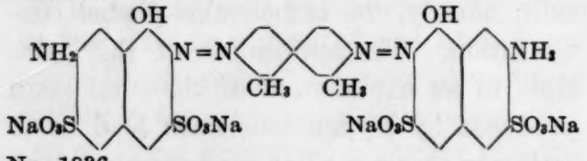


No. 1846

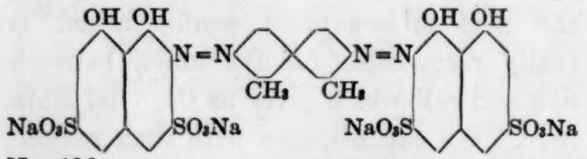


Furthermore, the production of exactly as brilliant a result by dyes in which merely the position of the OH group has remained constant, the NH_2 group either being absent or shifted in its position, might lead us to suppose that it is the alpha position of the hydroxyl radicle rather than the entire peri-amido complex which in all these cases has determined the vital stain. We mention of such dyes the vital stains 2836, 1836 dioxy, 1527, 136, 1368.

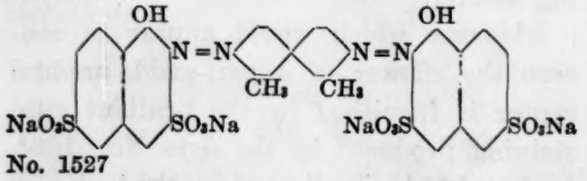
No. 2836



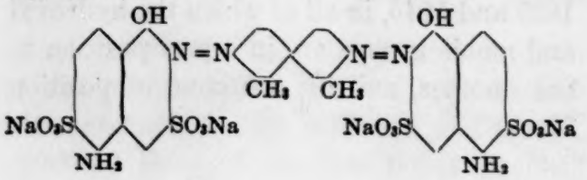
No. 1836



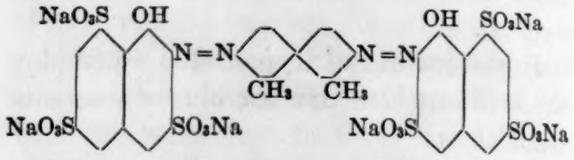
No. 136



No. 1527

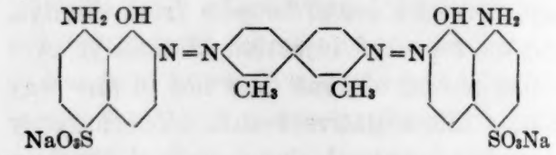


No. 1368

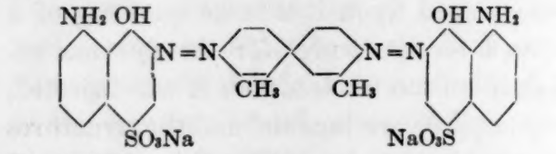


This conclusion, however, (*i. e.*, that an alpha-naphtol receptor has been responsible for the staining) must be rejected at once as soon as we examine the dyes 184, 185, 257, 258, 286, 184 dioxy 14 and 15 all of which can be injected into animals without producing a vital stain.

No. 184



No. 185



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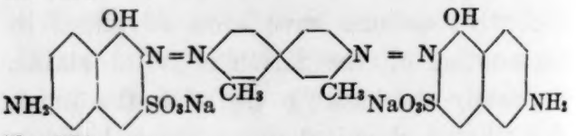

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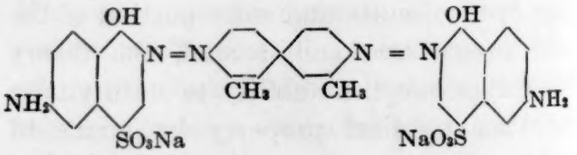

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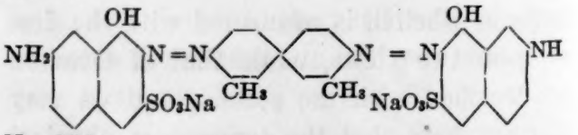
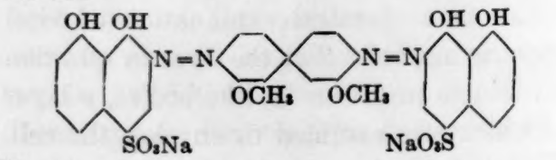
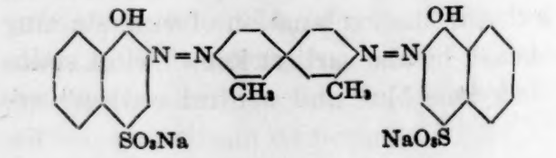


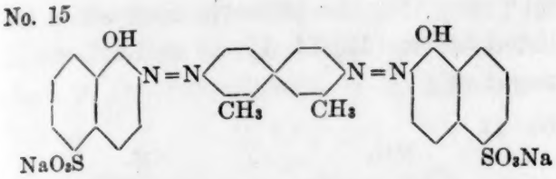
No. 184



No. 14

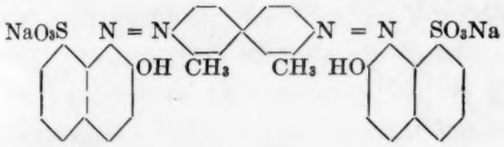


No. 15



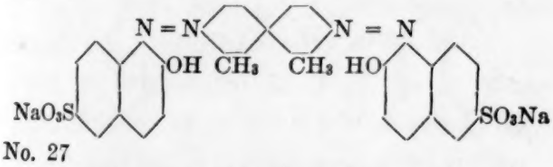
It is apparent then from the foregoing that if the alpha-naphtol receptor is to work, it can only do so in the presence of two sulfonic acid groups.

When, now, we examine the behavior of the beta-naphtol sulfonic acids in this respect, we find that, strangely enough, one of the monosulfonic acids (namely the 2.8 acid) produces a dye which acts as a vital stain.[2]



The other mono acids which we have examined (the 2.6 and 2.7 acids) produce entirely negative dyes.

No. 26



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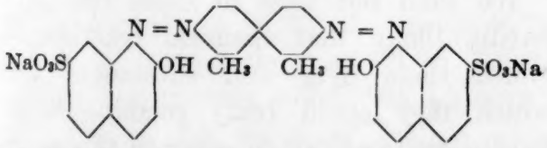
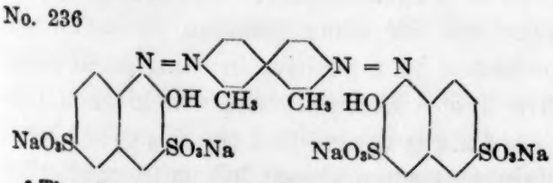


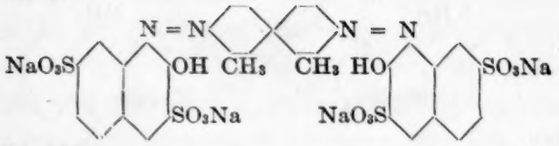
Whereas of the disulfonic acids, the 2.3.7 and 2.6.8 acids produce dyes which are non-stainers, the 2.3.6 acid combined with tolidine furnishes a dye which approaches a true vital stain.

No. 236



[2] The dye was made for us by Dr. Taggesel through the kindness of Schaellkopf, Hartford and Hanna, Buffalo.

No. 237



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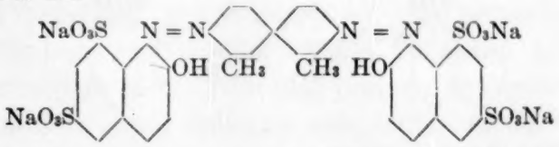
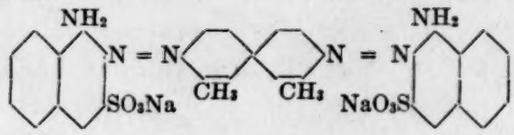


A comparison of the different effects secured by the two dyes 236 and 237 is interesting, for it is difficult to believe that the exact position which the sulfonic acid radicle assumes in the naphthaline ring is an adequate explanation of this. In all the dyes which we have examined, the number of sulfonic groups has been important, but not the position which they occupy. The precise point of insertion in the naphthaline ring was of little moment and we have to inquire in dyes 236 and 237 why the shifting of one SO_3Na group from 6 to 7 changes a positive into a negative dye. Now these two isomeric acids, apart from their close chemical relationship, have long been known to produce dyes which differ greatly in some of their non-chemical characteristics—characteristics which we believe determine whether a dye of the benzidine class shall be a vital stain or not.

For the present, however, let us believe that there is a general alpha-naphtol-disulfonic ceptor, a particular beta-naphtol-disulfonic ceptor (viz., the 236 one) and a particular beta-naphtol-monosulfonic ceptor (the 28 one) whereas none of the other monosulfonic and none of the other beta disulfonic acids have chemoceptors corresponding to them in the cell.

When we consider the dyes made from the naphtylamines we must still further extend our list of hypothetical chemoceptors, for many of these dyes are brilliant vital stains, among them 13, 15, 16, 26, 27 and 28.

No. 13



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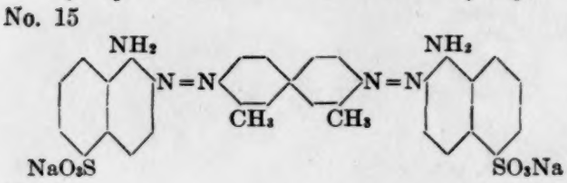

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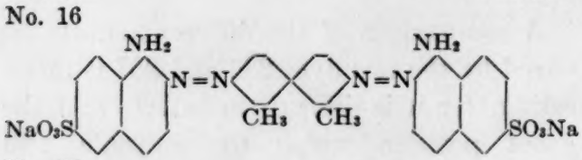

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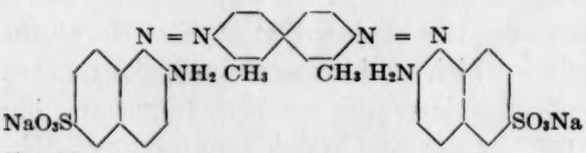

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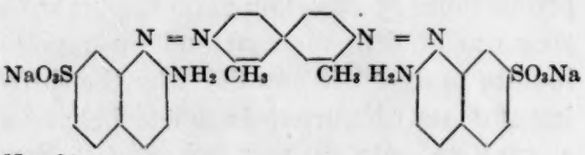

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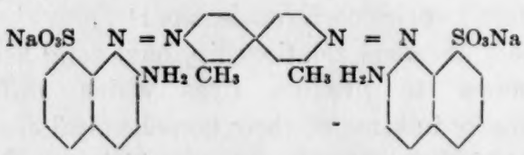
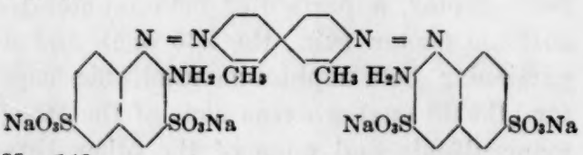
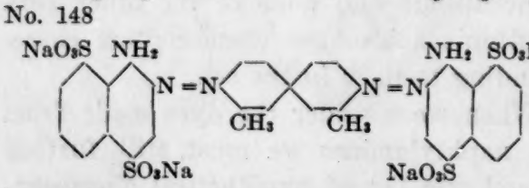


Both of the naphtylamine disulfonic acids with which we have worked have yielded equally brilliant results (the 2.3.6 and 1.4.8 ones).

No. 236

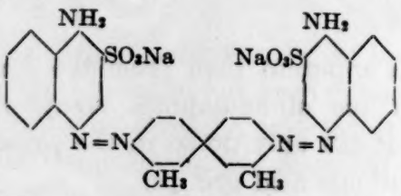


No. 148



We meet, however, among the naphtylamines surprises which are just as remarkable as those which greeted us in the naphtol group, for the isomeric dyes which are listed below (12, 14, 17, 18 and 25) are all negative.

No. 12



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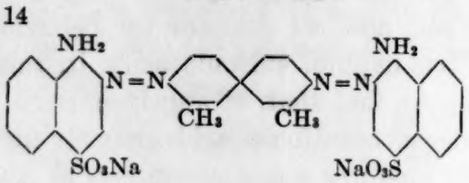

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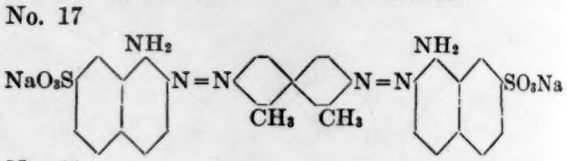

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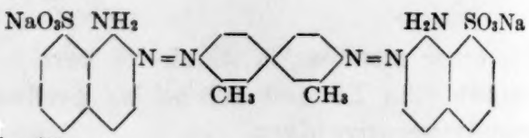

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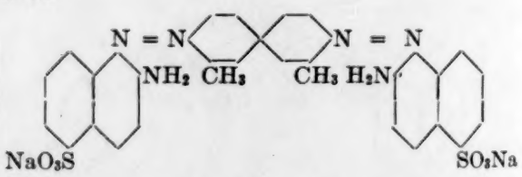
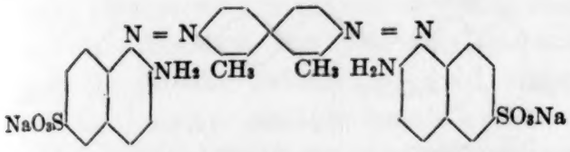


We shall not have to insist that it is hardly likely that chemical reaction between these dyes and substances with which they could truly combine would hardly occur or fail to occur in this capricious way. Our results then are hardly capable of being formulated in terms of the chemoceptor theory, for there is no one chemical configuration which we are able to pick as a chemoceptor. Our search at this juncture for some common characteristic possessed by a positive in contrast to negative dye, a characteristic which when possessed always permitted the dye to be a vital stain and when absent led us to predict its failure, was rewarded with success. We were in short induced to look into the phys-

ical state of the dye solutions. Our attention was rather dramatically called to this phase by experiments with benzo-purpurine B:

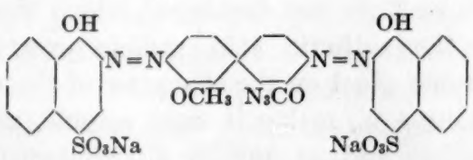


A fresh, cold one-per-cent. solution of this dye can be injected rapidly into the ear vein of the living rabbit and will produce within a few minutes a beautiful diffuse coloring of the whole animal, a coloring which though at first affecting merely the body fluid, can in a few hours be seen to have established itself in the form of granules in that distinct class of cells which are affected by dyes of this group. If, on the other hand, we inject a similar cold solution of this dye, but one which has been allowed to stand a few days before using, the animal invariably dies before our eyes with typical symptoms of cerebral embolism. If we boil the dye for a little while with Ringer's solution instead of with water, the effect is even more marked, for a single cubic centimeter of such a solution after it has been allowed to cool, kills the animal instantly on injection. Why are the dye solutions so different in their behavior? A few test-tube experiments sufficiently answered our question, for we were dealing with an electrolytic precipitation of a colloid, whose coagula were sufficient to plug the cerebral vessels. By testing in this way all of the dyes which we have reported as negative, we were able to show that no one of them failed to produce embolism on injection.

But while thus dangerous in the living blood stream there might still be thought to be no reason why these dyes should fail to act when placed under the skin or in the body cavity. In these situations, however, the dyes remain without invading much of the remainder of the body, and we were led to test the diffusion power of positive and negative dyes in a medium where it was slow enough to be measured, *i. e.*, in 2 per cent. gelatin, and without presenting here our tabular results we found no exception to the rule that positive dyes possessed a rapid diffusion rate, while negative dyes little if any diffusion at all.

These facts harmonize, of course, perfectly with our knowledge of the behavior of colloids, and make it certain that we are dealing with phenomena which depend on the size of the particles or aggregates in our solution. A negative dye could not reach many cells in the body, for its particles are all large and rapidly agglutinated in the body fluids, and such large particles have slight, if any, power of diffusion. Did, however, the cells in their neighborhood accept these negative dyes?

The investigation of the cells of the subcutaneous tissues at the injection site showed that even with the most negative dyes a vital staining in this limited zone had always taken place. Our failure to stain more cells then was due solely to our inability to reach them. We proved this contention, we believe, conclusively by selecting a dye D-14.

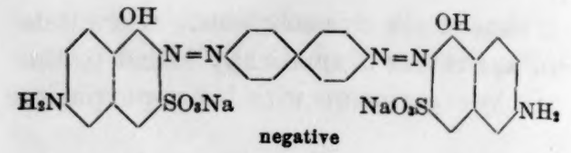


which when placed under the skin has practically no powers of diffusion and which when injected at a normal rate into the blood stream always kills with the typical picture of embolism. We found that the very slow injection of a perfectly fresh, cold one half per cent. solution in distilled water obviated this accident; and although for a few days the continual injection of

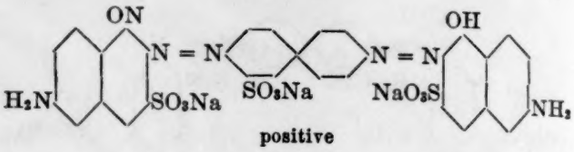
the dye did not color the skin or mucous membranes of the animal, this was eventually obtained. The study of an animal in the early stage of such a series of injections is most interesting. We have indicated that such a negative dye must consist chiefly of large particles, and since little color appears in the urine of these animals, and the animal is externally unstained, it is evident that the dye particles are engulfed by cells internally located. The autopsy of such an animal shows that not only the skin but most of its tissues are free from dye with four notable exceptions; namely the liver, the spleen, the lymph-glands, and the bone marrow, all of which are blue-black.

We do not believe that a heightened power to attract the dye is possessed by the cells in these localities. The skin cells in the neighborhood of a puncture take up the stain almost as rapidly, but they are unable to do it when the large dye particles are only circulating in the blood vessels, from which their lack of diffusion powers never take them, for they can not leak through the walls of the capillaries.

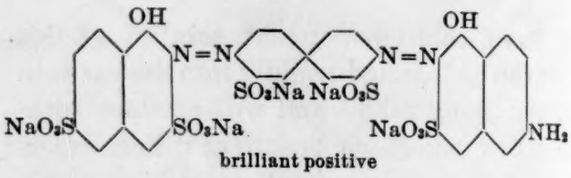
A glance at the list of positive and negative dyes which is just presented shows us that most positive dyes are disulfonic acids, a statement, in view of the ideas which we have just developed, which means that the sulfonic acid radicle exerts a favorable effect on the character of the dye solution, *i. e.*, makes it more soluble, more diffusible, and, so, quickly distributed, that is, *a true vital stain.* Evidence to this effect has already accumulated in a comparison with the positive and negative dyes 184, 185, 1846, 1824 and 1835, but this conclusion is, we think, substantiated in a more complete and overwhelming way by the sulfonation of a number of negative dyes by which means brilliant, positive stains were always secured. We cite as a good example of this



negative

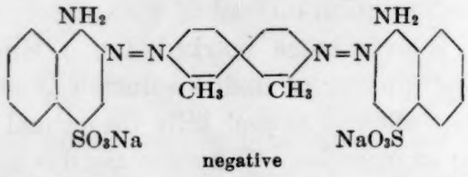


positive

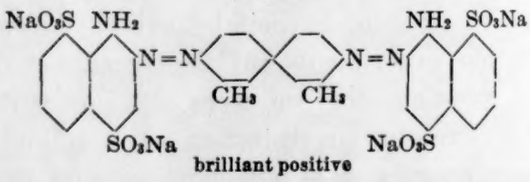


brilliant positive

Identical results were secured with the 2.8 amido naphtol 6 sulfonic acid combined with benzidine, with benzidine monosulfonic acid and with benzidine disulfonic acid; and a similar effect of sulfonation is seen in the brilliant tetra-sulfonic congo red dye made from the 1 naphtylamine 4.8 disulfonic acid, whereas the congo red monosulfonic acid (the 1 naphtylamine 4 sulfonic acid) or naphtionic acid yields a dye which is not a vital stain.



negative



brilliant positive

In this connection the question of whether or not it was possible to over-sulphonate the dye was attempted with interesting results. The sulfonation of diamine blue 2B gives us a dye which while a vital stain nevertheless passes the kidney much more rapidly than the original body, so that after an intense stain the animal is decolorized again in a few days. We have secured identical results in experiments with a similar sulfonated trypan blue.

The staining with acid azo dyes then is a physical phenomenon, and when we turned our attention to the likelihood of other solutions or pseudo-solutions giving an identical picture we are able to say that such is indeed the case, for those excellent suspensions of fine particles of gold, silver, palladium and some other metals which are called colloidal solutions eventually stained an animal just as did our vital dye. This effect has in fact been known for a long time for the so-called argyria, a pigmentation of the mucous membranes of workers concerned with silver salts, is a similar storage of particles formed by the silver when it meets the fluids in the body.

It remains now to discuss briefly what cells or tissues in the body are selectively affected by these stains. We can do this best by describing the autopsy of an animal which has been injected, on two occasions three days apart, with trypan blue and killed the day following the last injection when the animal with every appearance of health is intense blue. The skin of the abdomen when stripped back is seen to be intensely stained, but freshly spread preparations from the subcutaneous tissue show that the color is only to a minor degree due to the coloration of the fluids, but mainly to great numbers of small though dense granular deposits in certain cells. The larger and more striking of the cells possess a large slightly irregular oval nucleus, and an elongated cell body with frequent though always sharply defined pseudopodia or larger cell processes. Irregularly scattered through the cytoplasm are the granular deposits of the dye, and the larger of these are always comprised in a vacuole inside of which both larger and tinier fragments are in liveliest Brownian movement. We have identified these large, brilliantly stained cells of the skin and connective tissue of the body as the cells which have been designated variously by histologists as the resting wandering cells (Maximow); the clasmatocytes (Ranvier), the adventitia cells (Marchand) and the rhagiocrine cells (Regaud). At the same time in smaller, although more abundant cells, cells with more regularly oval nuclei and with faintly defined nuclear membrane and cytoplasmic boundaries, in these cells are fine scattered granules of the stain. These are, we believe, the most abundant and typical cells of connective tissue and are probably those designated as fibroblasts by the majority of investigators. None of the blood cells nor the endothelial cells of the capillaries of the skin carry the minutest trace of the dye. The muscles of the body, instead of their customary pink hue, are greenish in color, due to the infiltration in the minute connective tissue septa of countless numbers of these vitally stained cells of both types. The peritoneal cavity contains a normal amount of fluid which is pale blue in color and in which are suspended many vitally stained cells. The most brilliant of these and the largest are those cells which have been designated by Mechnikoff, Schott and others as makrophages—cells which, spherical in shape, are covered with delicate pseudopodia, and the cytoplasm of which is often a frothy mass of vacuoles, in which are always particles of the dye. We can trace all transition stages from these cells to those but slightly larger than lymphocytes, all of them containing some inclusions of the vital stain.

The cells which line the peritoneum, the mesothelial cells of Minot, possess in a peripheral zone the fine granulations which are characteristic of the cells of type 2 in the skin.

Of the peritoneal organs the liver and kidney are undoubtedly the deepest stained, for they are almost a blue black, a color due in the liver almost exclusively to the inclu-

sions of the dye by the cells of Kupfer of the hepatic capillaries and in the kidney to a similar behavior shown by the epithelial cells of the proximal convoluted tubules. The spleen and lymph glands are stained a paler though still brilliant blue and the color is due in these organs to the granules carried by the so-called reticular and by the true lymphatic endothelial cells.

In the testis the interstitial cells of Leydig are stained brilliantly, although the granules here are singularly regular and intermediate in size between those possessed by cells of type one and two in the skin. In addition, true vitally stained connective tissue cells of type two are also present between the seminiferous ducts, but the epithelial cells of the seminiferous tubules never contain the slightest trace of the dye.

The pancreas possesses in the connective tissue septa of its acini brilliantly stained cells of type one, although no particle of the dye is found in the pancreatic parenchyma.

The thoracic cavity presents a remarkable picture, for its deep blue walls enclose the lungs which have preserved their normal pink color, and in which few vitally stained cells are found. The heart, however, contains many of these, for not only do the epicardial cells receive the dye like the mesothelial ones, but also many connective tissue cells of type one infiltrate its musculature at many points.

The thymus, thyroid and parathyroids owe their generally lighter stain to similar cells which follow the connective tissue in its structural relation to these organs.

Most remarkable is the behavior of the central nervous system, for with the exception of the hypophysis and choroid plexus the nervous system contains no trace whatever of the dye, and its whiteness in contrast to the stain of the other tissues is a strange sight, the more so because the dura is always densely stained.

With the exception of the kidney, the epithelium of whose convoluted tubules comes from the middle germ layer, the great mass of the epithelium of the body refuses to react to the stain. Most remarkable also is the rejection of the dye by the blood cells, whose polymorphonuclear elements have always been supposed to play so great a rôle in phagocytizing foreign particles.

It might possibly be supposed from the comparative physical measurements we have made on the dyes that the so-called vital stains or vital granules, which we have just described, are an expression merely of diffusion, especially inasmuch as the most diffusible dyes of this class are the most satisfactory vital stains; but we have explicitly pointed out that heightened diffusion powers effect the vital stain merely by enabling the dye molecules or dye-molecular-complexes to present themselves to the class of cells which will receive them in every corner of the body. Having arrived at the cell, the dye by no means diffuses into it, as we can see, for instance, various basic dyes (neutral red, methylene blue, janus green) diffuse into a cell, advancing from periphery to center, and lodging often with special avidity in some preformed granule or structural element of the cell (*e. g.*, mast cell granules with thionin or neutral red, Nissl bodies with methylene blue). The benzidine dyes, let in more slowly at the cell's periphery, never encounter physical conditions which favor their rapid spread and they are disposed of by the cell by being concentrated at various points where they are doubtless set apart from the cell's protoplasm. The vital granules then deserve their designation, for they are always the result of the behavior toward the dye on the part of a living cell. Dead cells behave quite differently, for into their protoplasm, including the nucleus, the benzidine dyes diffuse rapidly, produc-

ing a uniform stain. Nothing is more striking than the way in which dead cells are stained in this manner. Liver cells selectively poisoned by chloroform[3] and renal cells killed by sublimate[4] both permit an immediate diffusion of the dye into them and resultant stain; and even the nerve cells, normally hostile to the entry of a single trace of the dye, receive it similarly when killed, an elegant example of which is furnished by the anterior horn cells in experimental poliomyelitis.[5] When we tap the cover slip over leucocytes swimming in trypan-blue, mechanical injury to the immediate subjacent cells invites instant entry of the dye.[5a]

It is evident then that into the dead cell a true diffusion takes place, but if diffusion be acting at all in the case of those living cells which react to the vital stain it is at least seriously hampered. There is in fact no reason for the identification of the vital stain with a diffusion phenomenon. It is significant that the cells which take the benzidine dyes are predominantly those endowed with powers of phagocytosis, a process long known to be operating in the case of particles from approximately 10 to 1 micron in size but it is not improbable that the colloidal particles of the benzidine dyes, whose dimensions must lie below a hundredth of such size, are received into the cell in an essentially similar way. Owing to their comparative minuteness, however, these particles are enabled to gain entry into many cells quite incapable of receiving larger ones. The fibroblast and mesothelial stains are examples of this. Yet in none of these cases does the cell, as it were, drink in the dye particles, as it does the freely diffusing ions of a salt solution. Nor indeed are the dye molecular-aggregates phagocytized in the usual acceptation of the term, for there is not merely a protoplasmic flow around a foreign body. Countless ultramicroscopic particles of the foreign body are let into the peripheral protoplasm and collected in the more central lying depots which we can at last recognize under the microscope as the dye granules.

This moving together or centralization of the dye in granules is not a reaction peculiar to the dyes, for an identical phenomenon is seen when colloidal silver is used, in which the particles have dimensions also considerably below the limits of ordinary microscopic vision and far below the dimensions of the intra-cellular granules in which they are later agminated.[6] Yet we have never hesitated to speak of the phagocytosis of silver aggregates in this later case.

We have to do then, in the case of cells which are stained vitally by these dyes, with a great host of elements scattered all over the body, serving in some special organs as the lining of blood and lymph vessels, but in the great interstitial tissue of the body without the vessels, equally abundant, cells whose primary function seems to be the engulfment of particles whose physical dimensions fall within certain limits. These scavenger cells, as it were, rid the blood and tissue juices of many kinds of useful and unuseful débris. How they do this may still be difficult to explain, but there seems no doubt but that their protoplasm in contrast to that of epithelial cells consists of a peculiar physical system.

[3] Experiments with Dr. Samuel J. Crowe, as yet unpublished.

[4] Gross, *Beitr. z. path. Anat.*, Bd. 51, p. 528, 1911.

[5] MacCurdy and Evans, *Berliner Med. Woch.*, 1912, No. 36.

[5a] Evans and Winternitz as yet unpublished.

[6] Bechold (*Zeitschr. f. chemie und Industrie der Kolloide*, 2 Jhrg., heft 1, 2) has determined that the aggregates of collargol-Heyden have a diameter of 20 $\mu\mu$. They consist of aggregates of metallic particles and particles of the schutz-kolloid together.

That useful and unuseful débris occurs normally in the body needs not, we take it, be defended, for the continual breaking down of some cellular elements of short life, the red blood corpuscles, for example, set free substances whose physical dimensions enable them to be engulfed by many of the cells which we have described (occurrence of blood pigment in liver, spleen, lymph glands and bone marrow) but that this reaction needs by no means be considered as one adapted for the engulfment of bodies of this class is proven conclusively by a number of observations made very recently by Ciaccio and others which go to show that fatty acids and lipoid substances are stored by the same cells. We are concerned then with cells of great physiological importance to the organism, cells whose action in this capacity, we believe, seems proven to be conditioned by physical and not chemical forces of response.

Herbert M. Evans,
Werner Schulemann

COMPARATIVE REGISTRATION STATISTICS[1]

One of the greatest difficulties encountered in the compilation of comparative university statistics is found in the apparent impossibility of securing uniformity. This difficulty is owing in large measure to two factors, one quantitative and the other qualitative. An illustration of the former is furnished by the fact that the student attending six weeks of summer session is recognized as a full unit, just as much as the student of an engineering school who annually puts in thirty-six hours a week for two half-years and several weeks in camp; and similarly a person engaged in secondary teaching who registers for a single late-afternoon or Saturday morning course counts as a full unit just as well as a candidate for the doctorate who spends his entire time at the university. Again, there are the students in so-called short courses, in agriculture, for example, who receive as much recognition as those who spend the entire year at the university. As a matter of fact, the most satisfactory solution along this line would be found in adopting a student-hour unit, but this, from the very nature of the case, would be an extremely complicated procedure. A simpler solution is reached by separating the summer session and short course students from those attending the entire year, and similarly by separating the full time from the partial time students. A difficulty would arise in connection with the point at which the line between these two groups is to be drawn, but this could readily be adjusted by agreement between the institutions involved. In this connection it might also be pointed out that owing to the fact that many secondary schools graduate classes in January as well as in June, several colleges and universities are admitting new students in February; they spend only half a year at the institution, but are counted as full units. On the other hand, the number of regular students enrolling for work in the summer session in order to reduce their time of residence or to make up conditions is constantly on the increase.

So far as the qualitative distinction is concerned, it must be borne in mind that the size of a university gives no more indication of its efficiency than the population of a country does of its degree of civilization, or the size of a city does of the morals and social welfare of its inhabitants. Comparative registration statistics, as they have been published by the writer from time to time in Science and elsewhere, have therefore little qualitative significance, inasmuch as such items as standards of admission and advancement, efficiency of instruction, equipment, and the like, are necessarily ignored in the comparison. So far as we are concerned in the present instance, standards of admission constitute perhaps the most significant item. No student should, in my opinion, be counted in the enrollment of a university, who has not offered graduation from a secondary school for admission. For-

[1] Paper presented at the annual meeting of the American Association of Collegiate Registrars, Richmond, Va., 1914.

tunately the admission requirements in this country, owing to the influence of the Carnegie Foundation, the Association of American Universities, the American Medical Association and similar organizations, are being rapidly increased all along the line, but courses are still offered at several universities in which high-school graduation is not demanded for admission. The students registered in such courses should be rigidly excluded in the university total, but it is not always an easy matter for the outsider to determine who these students are, and consequently our sole dependence lies in the cooperation of the reporting officers of the institution concerned. Of less importance, though not entirely without significance, is the difference that still exists in entrance requirements for the professional schools, several of which insist upon a bachelor's degree, while others are still satisfied with high school graduation. It would seem that a student in a medical school who holds a bachelor's degree would have greater qualitative value, other things being equal, than one who has entered the school directly from the high school. The adoption by so many institutions of the so-called Columbia or combined-course plan, in accordance with which six years are devoted to work for the bachelor's and the professional degrees, is bringing about a certain amount of uniformity in this direction. Yet even where college graduation is demanded for admission to the professional schools, and more particularly to the non-professional graduate schools (political science, philosophy, pure science), some difficulty is encountered, inasmuch as the bachelor's degrees of American colleges are unfortunately not of equal value, and for that reason a number of graduate schools do not accept graduation from certain specified colleges for admission. This is a matter which only time can remedy, and fortunately there are indications that the work of these inferior institutions is slowly but surely improving. Comparative statistics of the professional schools showing the percentage of college graduates enrolled in these schools are therefore of distinct value.

A word should be said concerning the inclusion of extension students in the grand total enrollment of a university. As a matter of fact, extension students are frequently, quantitatively as well as qualitatively, on a par with summer-session students. They are, in many instances, at several institutions in most instances, graduates of high schools following work of college or university grade given by regular officers of the institution concerned, and there seems to be no reason why an extension student registered for a graduate course in literature should not be counted in the university's total with as much justification as the high school teacher who is enrolled as a candidate for the master's degree but attending only a single Saturday morning course. On the other hand, extension students are from the very nature of the case practically all partial-time students, and for this and several other reasons it is safer perhaps to keep them in a category by themselves. Auditors in attendance on a six-hour lecture course should not be included at all, as they sometimes are.

Considerable difficulty is constantly experienced in prevailing upon reporting officers to eliminate the item of double registration. The ideal table of comparative registration statistics would simply ignore this item; where it is not ignored, an element of unfairness is at once introduced. The student should be considered primarily registered in one faculty only, and if he happens to be enrolled in a combined course, he should, for example, in his third and fourth years as a candidate for the bachelor's degree, which coincides with the first and second years of his candidacy for the medical or engineering degree, be counted either as a college student or as a medical or engineering school student, but not, as is frequently done, as both. The latter method unduly swells the size of the individual faculties of the institution. Similarly, the students at Columbia University enrolled as candidates for the master's or the doctor's degree and with the major subject in education should be included either in the faculty of philosophy or in Teachers College, but not in both. In

such cases a footnote can readily be added calling attention to the actual state of affairs. Where the enrollment at a summer session is included, the item of double registration giving the number of students in attendance on the summer session who returned for work in the fall is of course unavoidable.

So far as the individual tables of statistics prepared by the office of the registrar are concerned, I consider the geographical distribution figures as among the most valuable, especially in view of the fact that these are not prepared by the Commissioner of Education. In the preparation of these statistics it should be borne in mind that students are often inclined to enroll from the town or state in which the institution in question is located, instead of from their actual home. A distinction should be drawn, for example, between the Chinese student who spends four years in this country and returns to his native land, and the student from Germany who enters one of our professional schools and contemplates remaining in this country. Statistics of birth are also valuable, although rarely compiled. This applies also to statistics indicating the vocations of the students' fathers.

In connection with tables illustrating changes in enrollment covering a period of years, attention should also be called to the *percentage* of increase (or decrease), which is usually more valuable in connection with comparative statistics than a mere statement of growth in student units.

So far as tables illustrating specific items of registration are concerned, I would respectfully recommend the suggestive tables and diagrams included in the recently published annual report of the registrar of the University of Illinois, which possess the merit of simplicity and clearness.

In my opinion the wide distribution of university statistics is just as valuable as the dissemination of statistical material compiled by the census office, only it must always be borne in mind that in connection with an educational institution size is by no means a primary consideration. Entirely as much fault may be found with an overgrown department, school or university, as with an overgrown boy, city or potato. It is always necessary, in the case of comparative figures, to read between the lines, although there is no doubt of the fact that not infrequently the large enrollment in a particular school is due to the well-deserved reputation which this school enjoys, as witness the Harvard Law School, the Johns Hopkins Medical School and the Columbia Graduate School. Any attempt, however, especially on the part of overzealous alumni, to overemphasize size at the expense of efficiency, should be deplored. In this connection the following paragraph in the last annual report of President Butler will be of interest:

> The popular mind is easily impressed with size, and particularly with large numbers. The fact that Columbia University has under its influence and instruction many thousands of students is annually heralded in the public press as entitling it to claim precedence over other institutions at home or abroad. Within the university itself no such feeling prevails. The growth in numbers so marked in recent years, is, of course, gratifying in so far as it indicates that the curriculum, the equipment, and particularly the teachers and investigators of Columbia are sought on their own account. But we deplore growth in numbers unless it were accompanied by a steady increase in the quality of the students. . . . What should concern us is the quality, the character and the homogeneity of the several units of which the total is composed.

Rudolf Tombo, Jr.
Columbia University

Arthur Henry Pierce

Arthur Henry Pierce, for fourteen years professor of psychology at Smith College, died of pneumonia, after a brief illness, on February 20, at Northampton, Mass. He was born in Westboro, Mass., July 30, 1867. He graduated at Amherst in 1888 and for two years thereafter taught mathematics in the college. His post-graduate studies in psychology were pursued at Harvard, where he received the master's degree in 1892 and the doctor's degree in 1899, and at the universities of Berlin, Strassburg and Paris, which he frequented in the years 1894–1897. He was the first holder

of the Kellogg University Fellowship, his tenure of which lasted from 1894 to 1900. In 1900 he was appointed professor of psychology in Smith College. He was an active member of the American Psychological Association, being for three years its secretary (1908–1910) and for another three years a valued member of the council (1911–1913). For the past four years he was editor-in-chief of the *Psychological Bulletin*. His first contribution to psychological science was an investigation on phenomena of attention conducted in collaboration with J. R. Angell in the Harvard laboratory and published in 1892. Two years later he published a paper on the localization of sound. For several years he made a careful study of geometrical-optical illusions. The results of these researches were collected into a volume, the "Studies in Auditory and Visual Space-Perception," published in 1901. Since then his attention as a psychologist was largely given to phenomena of dreams, hypnotism, subconsciousness and synesthesia, in which field the most important of his publications was the noteworthy paper entitled, "An Appeal from the Prevailing Doctrine of a Detached Subconsciousness," published in the Garman memorial volume in 1906.

Arthur Pierce was a man of singular breadth, balance and clarity of mind, of equable temper and of rare personal charm. All his work as teacher, investigator and administrator was marked by thorough conscientiousness and careful attention to details. His cheerful disposition, his unvarying courtesy, his quick, yet unobtrusive, sympathy, his resourcefulness and his practical good sense made him universally admired and beloved and his loss will be deeply and widely felt not only by his psychological colleagues, but by many in diverse walks of life who counted him as a loyal friend.

H. N. G.

THE FAIRPORT BIOLOGICAL STATION

THE biological laboratory of the United States Bureau of Fisheries, Fairport Station, will be opened for general biological investigations in the early part of the coming summer. This is the first permanent laboratory established by the government for the special study of freshwater biology and problems relating to freshwater fishery resources. The station is located on the Mississippi River twenty miles west of Davenport and eight miles east of Muscatine, Iowa, on the main line of the Rock Island railway between Chicago and Kansas City. Chicago, Milwaukee and St. Paul Railway trains from Chicago to Kansas City also pass through Fairport, using the Rock Island tracks.

The Fairport station was established by Act of Congress for mussel propagation and biological investigations. It has been in construction for several years, during which period the permanent staff of the station and a few associates have been engaged, apart from the propagation work, in experiments and other forms of investigation, both at the station and in the field in various parts of the Mississippi basin. Small temporary quarters were occupied.

The permanent laboratory building, which is about 50×100 feet, was constructed last year, and it is now largely equipped and ready for summer occupancy. The two main stories of the laboratory building comprise a general laboratory, and several smaller special laboratories, a library, storeroom, offices and six bed-chambers. On the third floor are additional bed-chambers and storage compartments, while the dining-room and kitchen are located in the basement. The building is supplied throughout with filtered water from an underground concrete cistern on the hillside.

On the grounds below and above the railway are ten earth ponds, the largest of which is an acre and a quarter in extent, and fourteen small concrete-lined ponds of different forms and depth. There is also a tank house, twenty-five by fifty feet, in which are various tanks and troughs. The ponds and the tank house are supplied with unfiltered river water drawn by gravity from a storage basin holding about two million gallons. The pumping equipment consists of three steam-turbine-driven pumping units of a maximum pumping

capacity of about three million gallons per day. An artesian well on the grounds near the river offers a limited flow of hard water, which is not stored.

The grounds comprise sixty acres of cleared and wooded land, mostly with a gentle slope, and extending from the banks of the river to the top of the bluffs. The river frontage is about a quarter of a mile.

The station has two launches and a number of rowboats, with one portable Evinrude motor. A fishing crew is engaged almost daily. Opportunities are, therefore, offered for collecting in the various parts of the river or in the lakes and slues which are found in the islands and the lowlands of the Illinois shore. Interesting aquatic environments are also presented by the ponds on the station grounds, which are generally very rich in plankton.

The laboratory will not only be used by the permanent staff and associates of the bureau engaged on special problems, but it is desired to extend the facilities of the institution to other investigators desiring to study problems for which the conditions at Fairport may be particularly favorable.

The laboratory is furnished with the ordinary glassware and scientific apparatus. No charge will be made for occupancy of tables or dormitory rooms, but the mess will be operated upon a cooperative plan, each participant sharing in the expense. Further conditions and information will be supplied upon request.

Since only a limited number can be accommodated in the first season, it is requested that applicants for tables address the Commissioner of Fisheries, Washington, D. C., or the director of the biological station, Fairport, Iowa, as early as practicable. Investigators requiring the use of special or unusual apparatus should communicate particularly with the director, in order that they may be informed as to the special equipment of the station related to their needs.

Robert E. Coker,
Director

March 2, 1914

A NATIONAL ASSOCIATION OF UNIVERSITY PROFESSORS

In the spring of 1913 a circular letter, signed by most of the full professors of the Johns Hopkins University, was sent to members of the faculties of nine other universities, inviting them to consider the advisability of the formation of a national association of university professors, and to send delegates to an informal conference for the discussion of the matter. The letter contained the following statement of the reasons actuating the signers of it:

> The reasons which seem to demand the formation of such an association are fairly evident. The university teacher is professionally concerned with two distinct, though related, interests. Both of these interests can be furthered by cooperation and the interchange of views, and therefore, by organization; for only one of them has suitable organization yet been attained. As scholar and investigator the teacher is interested in the advancement of learning and the diffusion of knowledge in his specialty; and cooperative effort for these ends is already effectively organized, through our numerous technical societies and the several sections of the American Association. But the university professor is also concerned, as a member of the legislative body of his local institution, with many questions of educational policy which are of more than local significance; he is a member of a professional body which is the special custodian of certain ideals, and the organ for the performance of certain functions essential to the well-being of society; and concerning the character, efficiency, public influence and good repute of this body he can not be indifferent. It is on this side that there is need for more definite and more comprehensive organization. The general purposes, therefore, of the contemplated association would be to promote a more general and methodical discussion of the educational problems of the university; to create means for the authoritative expression of the public opinion of the profession; and to make possible collective action, on occasions when such action seems called for.

A favorable response was received in all cases, and statements expressing the belief in the desirability of the formation of such an association were drawn up and signed by members of the faculties of most of the uni-

versities addressed. The proposed conference was held in Baltimore on November 17, 1913, on the eve of the annual meeting of the National Academy of Sciences. It was attended by eighteen delegates, from the following universities: Clark (Professors Taber and Webster); Columbia (Professors Cattell and Dewey); Cornell (Professors Bennett and Nichols); Harvard (Professor Minot); Johns Hopkins (Professors Ames, Bloomfield, Lovejoy, Morley); Princeton (Professors Capps, Kemmerer, Warren); Wisconsin (Professors Cole, Marlatt), and Yale (Professors Harrison, Mendel). After prolonged discussion of the whole subject it was unanimously voted that the organization of the proposed association should be undertaken; and the chairman, Professor Bloomfield, was authorized to appoint a committee, representing the principal subjects of study and the principal universities, (*a*) to determine what professors, or classes of professors, should be invited to attend a meeting, to be held at some time during the current year, for the formal establishment of the association; (*b*) to determine the time and place of this meeting, and (*c*) to prepare a draft of a constitution. After some unavoidable delays, the chairman of the conference has announced the composition of the committee as follows: Astronomy, George C. Comstock (Wis.); Biological Sciences, E. G. Conklin (Princeton), R. G. Harrison (Yale) and Theodore Hough (Virginia); Classical Philology, E. Capps (Princeton); Chemistry, Julius Stieglitz (Chicago); Economics, M. A. Aldrich (Tulane), Alvin S. Johnson (Cornell); Education and Psychology, John Dewey (Columbia); Engineering, Guido Marx (Stanford); English, J. W. Bright (Johns Hopkins), C. M. Gayley (California); Geology, W. H. Hobbs (Mich.); Germanic Philology, M. G. Learned (Penn.); History, W. E. Dodd (Chicago); Law, Roscoe Pound (Harvard); Mathematics, C. J. Keyser (Columbia), Henry Taber (Clark); Medicine, C. S. Minot (Harvard); Oriental Languages, Morris Jastrow (Penn.); Philosophy, A. O. Lovejoy (Johns Hopkins), Frank Thilly (Cornell); Physics, C. E. Mendenhall (Wis.); Political Science, Isidor Loeb (Missouri); Romance Philology, F. M. Warren (Yale). Professor Dewey has consented to act as chairman.

In selecting the members of this committee of twenty-five, the chairman of the conference has, of course, had in mind three criteria: the representation of the principal universities, the representation of the several sciences, and the special qualifications of individuals for service upon such a committee. With very few exceptions those first asked to serve upon the committee have readily agreed to do so. In two or three instances, however, it has been necessary to leave important universities thus far unrepresented, owing to the inability of the professors first invited to serve, and the inexpediency of further delaying public announcement of the committee's membership until other representatives of those institutions could be selected and notified, and their acceptances be received. The committee may be expected to begin at once the consideration of the questions submitted to it; and it will doubtless be able to announce the date of the contemplated meeting, and its general proposals with respect to the association, within a few months.

SCIENTIFIC NOTES AND NEWS

THE College of Physicians of Philadelphia, the American Philosophical Society, the Library Company of Philadelphia, the Jefferson Medical College and the Academy of Natural Sciences have arrange a memorial in honor of the late Dr. S. Weir Mitchell, to be held on the evening of March 31, in the Hall of the College of Physicians. Addresses will be delivered by Dr. Talcott Williams, New York City; Dr. William H. Welch, Baltimore, and Mr. Owen Wister, Philadelphia.

DR. CHARLES W. ELIOT, president emeritus of Harvard University, celebrated his eightieth birthday on March 20.

A PORTRAIT of Dr. James Ward, professor of mental philosophy at the University of Cambridge, by Mr. Ambrose McEvoy, has been presented to the university.

The University of Cambridge proposes to confer on the occasion of the opening of the new physiological laboratory on June 9 the degree of doctor of science on Sir William Osler, Sir David Ferrier, Sir E. A. Schäfer and Professor E. H. Starling.

The opening ceremonies of the Institute for Medical Research, founded with an endowment of $1,000,000 by Mrs. George William Hooper in memory of her husband, were held on March 7 at the University of California Hospital, San Francisco. Addresses were made by Dr. Henry S. Pritchett, of the Carnegie Foundation, on "The Value of Medical Research to a Great City," and by Dr. Richard Mills Pearce, Philadelphia, on "The Opportunity of the University in Medical Research."

The Vienna Prehistoric Society was recently founded with Professor Moritz Hoernes, of the University of Vienna, as its president.

On the occasion of the thirtieth anniversary of the Circolo Matematico of Palermo a gold medal will be presented to Dr. Giovanni B. Guccia, founder of the society and editor of its publications.

The Hon. Bertrand Russell, of the University of Cambridge, has taken up his duties at Harvard University during the second half-year.

Professor Charles E. Bessey, of the University of Nebraska, is spending the month of March at the Desert Botanical Laboratory of the Carnegie Institution near Tucson, Arizona. Professor Bessey plans to study and collect material of numerous species of the desert flora. While he is away Dr. R. J. Pool is in charge of the department of botany at the University of Nebraska.

Professor William T. Sedgwick, head of the department of biology and public health at the Massachusetts Institute of Technology, has been given leave of absence for the present term, on account of a recent illness. He will pass the time in southern Europe.

Mr. Frank Alvord Perrett, the American volcanologist, has been slightly burned on the hands and legs by an explosion of molten lava while studying the volcano of Sakura-Jima.

A testimonial dinner was tendered to Dr. Samuel Sheldon at the Hotel Astor on March 21 to celebrate a quarter of a century of service as professor at the Polytechnic Institute of Brooklyn.

The members of the Chemists' Club, New York, gave a complimentary dinner to Dr. Wolfgang Ostwald, of the University of Leipzig, on March 19.

Mr. Emil Huber-Stockar, engineer in charge for the Swiss government of the electrification of the Gothard tunnel and president of the Swiss national committee of the International Electrotechnical Commission, was a guest of honor at a dinner given at the Engineers' Club, New York City, on March 13, by Mr. C. O. Mailloux, president of the American Institute of Electrical Engineers.

Professor George Grant MacCurdy, of Yale University, has been elected a corresponding member of the Numismatic and Antiquarian Society of Philadelphia.

Mr. François E. Matthes, associate geologist of the U. S. Geological Survey, has been elected a corresponding member of the International Glacier Commission.

Professor H. H. Norris, until last year professor of electrical engineering in Cornell University, has accepted an appointment as associate editor of the *Electric Railway Journal*, and, beginning on July 1, when his term as secretary of the Society for the Promotion of Engineering Education expires, he will devote his entire time to that publication.

Carl Spencer Milliken has been appointed assistant superintendent of Agricultural Extension in the University of California, with headquarters at the Graduate School of Tropical Agriculture at Riverside.

Dr. Henry Norris Russell, professor of astronomy in Princeton University, lectured before the Columbia Chapter of Sigma Xi on March 24, the subject being "Eclipsing Variable Stars."

Professor Roswell H. Johnson, of the University of Pittsburgh, lectured before the department of geology of Columbia Univer-

sity on March 24 and 26, the subjects of his lectures being "The Origin of Petroleum and Natural Gas, New and Old Theories" and "Proposed Methods of Securing an Increased Yield from Oil-wells."

PROFESSOR ARTHUR W. GOODSPEED, of the University of Pennsylvania, lectured at Bucknell University on March 13 on "Radioactivity with Special Reference to Radium."

PROFESSOR F. E. LLOYD, of McGill University, recently gave a lecture before the Ottawa Field Naturalist's Club on the subject of "Abscession in Flowers, Fruits and Leaves."

PROFESSOR GEORGE GRANT MACCURDY, of Yale University, completed on March 10 a tour of the eastern Canadian circuit, where he lectured on "The Dawn of Art" by invitation of the Archeological Institute of America at St. John, Halifax, Quebec, Montreal, Ottawa, Toronto and Hamilton.

ADOLPH FRANCIS ALPHONSE BANDELIER, a distinguished authority on South American archeology, lecturer in Columbia University, died in Madrid, Spain, on March 20, aged seventy-four years.

DR. W. T. DUTTON, professor of mathematics and civil engineering at Allegheny College, in Meadville, Pa., has died at the age of sixty-two years.

PROFESSOR GIUSEPPE MERCALLI, director of the Mount Vesuvius observatory, and professor of vulcanology and seismology in the University of Naples, has died at the age of sixty-four years, having been burned by the overturning of a lamp, or perhaps murdered.

DR. EDWARD C. PICKERING, director of the Harvard College Observatory, has sent under date of March 10, the following bulletin:

> The following statement has been received from Professor W. H. Pickering, in charge of the Mandeville Station of this observatory: Attention was called to the lunar crater, Einmart, in A. N. 4704. It is there stated that its interior was very brilliant in January, 1913, but since March had been very much darker. This darkness persisted throughout the remainder of the year, and through January of this year. In February, however, it again brightened up, being about as bright as it was in February, 1913, though by no means as brilliant as in January of that year. As it is a large crater, 25 miles in diameter, the brightness of its interior may be easily observed, even with a small telescope and under unfavorable atmospheric conditions. This past month it has been clearly brighter than any area of similar size between it and the limb. This had not been the case since the previous March. In the preceding January it was the brightest area of that size visible at that time upon the Moon. All observations should be made immediately following the first quarter. The interior is full of fine brilliant detail, constantly varying, not only from night to night, but also from month to month. This observation is, however, probably too difficult for any northern telescope, since it requires not merely one, but a succession of fine nights.

THERE is in the Paris Museum of Natural History a skull, which, according to tradition, once enclosed the brain of Descartes. The *British Medical Journal* says that the Academy of Fine Arts recently invited Dr. Paul Richer, professor of anatomy in the Paris School of Fine Arts, and a member both of the Academy of Medicine and the Academy of Fine Arts, to compare by scientific methods, in collaboration with M. Gaston Darboux, the supposed skull of Descartes with the different portraits of the famous philosopher. Dr. Richer indicated on a plaster cast given him by the museum certain distinctive characters which are well marked on the head of the portrait painted by Franz Hals. It is said to be on these resemblances that Cuvier based the opinion that the skull is authentic, which he expressed in 1821. He next drew a skull, as closely adapted as possible, resembling that outlined in the portrait. Then he made a drawing of the museum skull posed with the same orientation and on the same scale as the head of the portrait. Lastly, he superimposed the two drawings. In his first drawing Dr. Richer marked certain points—at the root of the bones of the nose, on the external orbital apophyses, and on the nasal spine. These same points were repeated on the cast of the skull in the museum. By means of these marks it was easy to place with almost mathematical precision the skull in the posi-

tion which Hals had given his model. The superimposition of the two drawings showed an almost absolute agreement. On the other hand, other drawings made under the same conditions of several skulls taken at random, showed notable discrepancies. The same experiment was repeated with the other portraits of Descartes, namely, that by Sebastian Bourdon in the Louvre; that of Beck, of which there is a copy in the library of the institute, the terra cotta medallion of the Versailles Museum, and an old portrait by an unknown painter belonging to M. Rulhe, of Courvevoie. The comparison of the skulls in these different portraits with that of the museum shows some striking resemblances, but never so complete an agreement as was found with the Hals portrait. Before Dr. Richer began his investigation much the same procedure was employed by Dr. Verneau, professor of anthropology at the museum, who came to the same conclusion. As a matter of history it is known that the skull was detached from the philosopher's body in 1666 by Israel Planstrom, Captain of the Queen of Sweden's Guards, and it was given to the French nation by Berzelius. Now that the relic has been satisfactorily identified, it is suggested that it should be placed in the coffin which contains the decapitated skeleton of the philosopher. This is in the Church of Saint Germain des Prés, where it lies in one of the chapels between the remains of Mabillon and those of Montfaucon. Another suggestion is that the skeleton and skull might be solemnly transferred to the Pantheon in accordance with a decree of the Convention of October 2, 1793, to which effect was never given. At a meeting of the Académie des Sciences on January 20, Professor Edmond Perrier declared that the identification having been made conclusively, it was no longer right that this relic of the great thinker should be left amidst the collections of the gallery of anthropology and paleontology in the museum. He undertook to have a kind of reliquary constructed in one of the rooms of the museum where there are already relics of other famous men. There the skull of Descartes will be deposited, together with the documents establishing its authenticity.

UNIVERSITY AND EDUCATIONAL NEWS

Tentative plans for buildings to replace the burned College Hall of Wellesley College provide for a quadrangle, including four buildings, on the old site. It is expected that the college will be able to reopen on April 7.

Amherst College has received a bequest of $5,000 for a scholarship under the will of Addison Brown, late of New York, and a non-graduate of the class of 1852.

Under the will of the late Dr. Rosewell Park the medical department of the University of Buffalo will receive his entire medical library of about three thousand volumes.

The valuable psychological library of Dr. Arthur Henry Pierce, late professor of psychology at Smith College, has been given to the college.

It is said that the secretary of the interior has written to the chairman of the house committee on education expressing disapproval of the bill to establish a national university.

The first structure that the Massachusetts Institute of Technology has erected for its own uses on its site in Cambridge is the new aerodynamic laboratory. The building is finished and the apparatus is in process of installation. The portion of its equipment that is first to be installed is the four-foot wind tunnel with its accompanying blower. This is of the pattern now in use at the National Physical Laboratory at Teddington, England, which has furnished the plans.

It is expected that a school of fisheries will be established at the University of Washington. If the plans mature, the resulting school will be the first school of its kind in the United States, though there are such schools in Japan and other countries.

Professor Frederick Slocum, who for the past four years has been in charge of the solar observations and stellar parallax work at the Yerkes Observatory, has been elected professor

of astronomy at Wesleyan University, Middletown, Conn., and will assume his new duties in the autumn. A new observatory will be erected immediately as a memorial to the late Professor Van Vleck, for many years in charge of that department at Wesleyan.

DR. WILLIAM C. ALPERS, formerly a trustee of the College of Pharmacy of Columbia University, has been appointed dean and professor of pharmacy of the pharmaceutical department of Western Reserve University.

MR. ROBERT N. HOYT, '09, has been appointed by the corporation of the Massachusetts Institute of Technology special lecturer on public health administration.

MR. SEARCY B. SLACK, B.S., Georgia, '11; A.M., Harvard, '12, has been appointed adjunct professor of civil engineering and road expert at the University of Georgia.

PROFESSOR BURTON H. CAMP, who has been associate professor of mathematics at Wesleyan University, has been advanced to a full professorship.

DR. ELLIS M. FROST, instructor in clinical medicine and microscopic anatomy in the School of Medicine, University of Pittsburgh, has been appointed to the position of director of the department of health of the university.

DISCUSSION AND CORRESPONDENCE

SMALL AERIALS AND THE STRENGTH OF WIRELESS SIGNALS

FEW persons realize the ease with which wireless signals, such as are sent from the Navy station at Arlington, Va., and Sayville, Long Island, may be intercepted and read, even when one is some distance from the sending station.

In connection with some experiments on the effect of foliage, humidity, etc., on the strength of the wireless signals sent from the government station at Arlington, the writer was impressed by the large amount of power intercepted by an aerial erected on the university campus and an attempt was made to see if these signals could be read with a much less pretentious aerial. During the writer's summer vacation spent near Morgantown, W. Va., on the banks of the Monongahela River, a T aerial consisting of two No. 18 wires, 100 feet long, was stretched up between two trees on the side of a hill at the back of the camp. This aerial was approximately 30 feet high and 50 feet from the top of the hill. There were quite a few trees in the neighborhood of the aerial and in most cases they extended well above the highest point of the aerial. Some difficulty was met with in trying to find a satisfactory ground connection, but as soon as that was secured the "time signals" could be heard very clearly even in the brightest sunshine and on the warmest days of last August.

Upon the writer's return to Morgantown he found that not only the "time signals" from Arlington but the Sayville Long Island press dispatches could be heard with a T aerial consisting of three No. 18 wires, 30 feet long, fastened to the rafters in the attic of his residence. Later experiments showed that both these signals could not only be heard, but were loud enough to be read by using an ordinary iron bed with a wire soldered to the middle of one side for the aerial. The bed was located on the second floor of the house and was about 12 feet above the level of the street.

The receiving apparatus consisted of a Navy type of loose-coupled receiving transformer, a variable condenser, a silicon detector used without batteries and 1,000-ohm telephone receivers. A gas pipe leading to a gas stove in the room served as the ground line.

Morgantown is 162.3 miles from Arlington, Va., and 374.6 miles from Sayville, Long Island, with both the Blue Ridge and the Allegheny Mountains between. The peaks of some of these mountains rise as high as 2,200 feet above the top of the writer's residence and for the most part are covered with forests. In view of the distance from the sending stations and the mountainous character of the country over which these signals are transmitted the results obtained with these low and small aerials seem to warrant this brief description.

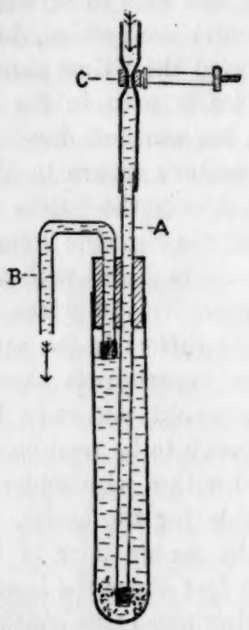
C. W. WAGGONER

WEST VIRGINIA UNIVERSITY,
MORGANTOWN, WEST VIRGINIA

A SIMPLE APPARATUS FOR WASHING SMALL AND DELICATE OBJECTS FOR SECTIONING

THE apparatus here described was devised for washing small and delicate objects fixed in Flemming-fluid. It has been found successful and economical for washing with distilled water also.

The apparatus consists of a *round-bottomed* glass tube, six inches long and one inch in diameter, a double-bored, tightly fitting stop-



per,[1] through which the inlet tube *A* and the U-shaped outlet tube *B* pass.

The inlet tube *A* should be inserted at a slight angle so that its lower end lies in the center of the round-bottomed tube within half an inch of the bottom. This end is covered with a piece of fine bolting-silk fastened with a rubber band. The bolting-silk breaks the force of the inflowing water, but more especially prevents the entrance of any foreign substance which might close the outlet. The upper end of tube *A* is connected by a rubber tube to the distilled water reservoir or faucet. The flow of water is regulated by screw compressor *C*.

The outlet tube *B* has its inner arm a trifle longer than the outer arm, so that the U does not act as a syphon. The inner arm of this tube is covered with bolting-silk also, to prevent the escape of any material which may float.[2]

With the water merely dripping, a liter per hour, the material is kept in constant motion and thoroughly washed.

S. I. KORNHAUSER

[1] The stopper and small tubes must fit tightly to maintain an air chamber between the stopper and the lower end of tube *B*.

THE CORRESPONDENCE OF LINNAEUS

TO THE EDITOR OF SCIENCE: Dr. J. M. Hulth, of the University Library of Upsala, who has succeeded to the editorship of Carl von Linné's correspondence, formerly edited by the late Professor Th. M. Fries, desires information as to the whereabouts of letters to and from Linné which might be found in collections in this country. Individuals or institutions having such letters are asked to communicate with the undersigned.

AKSEL G. S. JOSEPHSON
THE JOHN CRERAR LIBRARY,
CHICAGO, ILL.

EXHIBITION OF THE ROYAL PHOTOGRAPHIC SOCIETY

TO THE EDITOR OF SCIENCE: The Royal Photographic Society of Great Britain are holding their fifty-ninth annual exhibition in August and September of this year. This is the most representative exhibition of photographic work in the world, and the society is anxious to make it more international in character. It is very desirable that American scientific photography should be fully represented at the exhibition, and in order to enable this to be done with less work to the exhibitor, I have arranged to collect and forward American work intended for the scientific section.

This work should consist of prints showing the use of photography for scientific purposes and its application to spectroscopy, astronomy, radiography, biology, etc. Photographs should reach me not later than Friday, July 10. They should be mounted but not framed.

[2] If the objects to be washed tend to float, a disk of perforated celluloid through which the inlet tube passes may be placed about an inch from the bottom of the larger tube.

I should be glad if any worker who is able to send photographs will communicate with me as soon as possible so that I might arrange for the receiving and entry of the exhibit.

C. E. K. MEES

RESEARCH LABORATORY,
KODAK PARK,
ROCHESTER, N. Y.

SCIENTIFIC BOOKS

Definitions in Physics. By KARL EUGEN GUTHE, Ph.D., Professor of Physics in the University of Michigan and Dean of the Graduate Department. New York, The Macmillan Company. 1913. Pp. vii + 107.

A man's convictions are vastly more important than the logical processes by which he reaches them; and his convictions are represented in a large degree by the definitions which he adopts. It follows, therefore, that the appearance of a volume of definitions by a scholar of high standing in any particular field of thought is a matter of some moment. There is danger of taking physics too seriously; and nothing is easier than to employ definitions in such a way as to produce in the student-mind what Professor Franklin calls "a stress of dryness." But when the technical terms of his own science have been collected by a well-known specialist they become a matter of keen interest, and all the more so when that specialist is an experienced and successful teacher as is Professor Guthe.

Definitions grow as our ideas grow. They are not the fixtures of the Medes and Persians. Compare the modern definition of the crab with the classical one given in the French Academy's dictionary. Or consider how the resistance term in Ohm's law developed into impedance upon the introduction of alternating currents. Previous to the renaissance forces were defined only in a statical way; anything that would flatten out the muscles of the hand, bend a beam, disturb the configuration of a steelyard, or bring out any other strain requiring work was classified as a *force;* and conversely the term *force* was used at that time to include many ideas, such as *speed, impulse, energy* and *power,* which now lie quite without its limits. Shortly after the renaissance the concept of force was enlarged so as to take in the time-rate of change of momentum; later the generalized forces of Lagrange are included. Again the Peltier effect is defined quite differently from what it was before the Thomson effect was discovered.

A list of definitions is therefore a list of variable quantities and can hardly be regarded as more than a cross-section of the conventions agreed upon by the generation which uses them.

The book under review is one which can not fail to be of the utmost help to any student of general physics. The definitions are arranged under the classical five chapters of physics. Each quantitative concept is, as a rule, first defined in simple English and in terms already explained or assumed; next follows a mathematical expression which may be considered as a repetition of the first definition, and frequently, as an expression of natural law. The definitions are remarkable for their clearness, simplicity and brevity; if at any point indefiniteness suggests itself one feels that additional details have been omitted only to secure brevity. This feature is illustrated by the first paragraph in the book which defines *physics* in a manner which is elegant but so general as to leave doubt in the reader's mind as to whether physics and physical science are one and the same.

At the outset the author enunciates his conviction that "certain concepts used in physics are deductions and generalizations from individual experience and can not be strictly defined. Such are the concepts of *extension* (space, with its subdivisions of volume, area, length and direction), *time, force, warmth, cold,* etc." On the same page, a *physical quantity* is defined as "a definite concept capable of measurement."

Every one who thus finds *force* listed among the indefinables will surely understand that Professor Guthe here means to imply nothing more than that no complete and satisfactory definition has yet been given. For only a few

pages later we find that he himself offers the following definition:

"*Force* is the cause of a change or of a tendency to change in the state of rest of a body or of its deviation from uniform rectilinear motion. The idea of force is based upon the fundamental concept of the effort necessary to change the position of a body at rest or the uniform rectilinear motion of a body. It is assumed to be the cause of such a change, to be proportional to the acceleration produced, and to be in the direction of the added acceleration. It is a vector quantity. A force is measured by the equation $F = ma$, which may serve as a definition."

Waiving all considerations which might be urged against this definition on the ground that physics is not at all concerned with "causes," and laying aside all pedagogical considerations, your reviewer would like to ask, purely for information, this one question: Is there any single property, save only the space-variation of energy, which is characteristic of all the physical quantities which one finds labelled as "forces" by the leading physicists of the present time? Is there any single feature, or set of features, which can serve as a defining quality for force? No question is here raised about any general definition of force such as that which occupies ten columns of fine print in the great Oxford Dictionary. *The inquiry here made is much simpler. It pertains only to the forces which are employed every day in physics.* The one and serious objection against defining force in terms of energy or work is, of course, the fact that work and energy are universally defined in terms of force.

The crux of the situation would then appear to be the following: one is compelled either to employ the vicious circle just indicated or to discover some property other than space-variation of energy, which is common to all forces. It goes without saying, perhaps, that the space-variation here referred to is that employed by Lagrange in his definition of generalized force,[1] and is intended to include both angular and linear space. To make it perfectly clear that there is nothing hazy or indefinite about the query here raised it may be well to summarize the principal types of force which one meets in any standard discussion, such as that of Thomson and Tait, or Webster.

1. First of all there is the straightaway mass-acceleration in which the momentum of a particle is altered while its direction of motion remains constant, *e. g.*, a particle falling under gravity.

2. The force which produces a change in the direction of momentum of a particle, leaving the scalar value of its momentum constant, *e. g.*, contrifugal force, $mv\omega$.

3. The non-conservative force which is independent of the speed and is illustrated, within limits, by that of sliding friction. One may of course assign a part of the force of friction to the mass-acceleration of the small abraded particles.

4. The non-conservative force which varies directly as the speed, and possesses a dissipation function, illustrated by certain viscous resistances. Here again one may assign acceleration, hence speed and heat, to the small invisible particles.

5. The force which produces a change in the shape or size of an elastic body or in the configuration of a gravitational, magnetic or electric system.

The reader will find a more elegant analysis of the typical mechanical forces in Webster's "Dynamics," p. 123; but the above list suffices to show the diversity in which some common factor is sought. If we admit that a mass-acceleration is characteristic of the first four types listed above, can the all-powerful electron theory bring the fifth type also into this category? Or is there some better way around this *impasse?* Or must we concur with Professor Guthe in his opinion that force can not be defined? To say that it is sometimes definable and sometimes not is about as satisfactory as that ancient testimonial of good character which asserted that "the man is honest; at least he is honest nine times out of ten." Even those who believe there is something profound and mysterious about the concept of force, just as there is something

[1] *Mec. Anal.*, I., p. 334.

away beyond our ken in the structure of matter, say of copper, will confess that the chemist can point to a certain set of properties which are necessary and sufficient to delimit copper from every other known substance. The question here raised is similar, namely, Can forces be grouped into a class by themselves? And, if so, what are the marks, or the one mark, by which this class is set off from the other physical quantities? Dr. Dadourian, in his "Analytical Mechanics," p. 15, has perhaps given an answer to this question: but if so, only by introducing a term—*action*—which the intelligent reader will consider an undefined synonym of *force*, equally complex and equally indefinite.[2] Every one agrees that a force is represented, in a general way, by a *push* or *pull;* but the question here raised is this: How is a *push* to be defined in a quantitative and consistent manner?

Returning now from this digression suggested by Professor Guthe's treatment of mechanics, the definitions in *Sound* and *Heat* are brief and excellent. Those in Magnetism and Electricity are introduced with the interesting remark that "the existence of ether in space is accepted as a means of interpreting phenomena that can not be explained by the properties of ordinary matter." The definitions which follow are especially fine and are certain to furnish new and helpful viewpoints to any serious student; the same is true of the section devoted to optics. Where differences of opinion might arise—and they are numerous—one feels always that the text, as it stands, clearly sets forth the essential facts of the case.

HENRY CREW

Introduction to the Study of Igneous Rocks. By GEORGE I. FINLAY, Ph.D. New York and London. McGraw-Hill Book Company, Inc. 1913. Pp. vii + 228. Price $2.00 net.

This little book is said by its author to be intended as an introduction to the exhaustive treatises on the subject of igneous rocks, and consists of a brief statement of the qualitative classification of igneous rocks; a description of the method of determining such rocks in hand specimens, and a short chapter on the optical properties of minerals and the methods by which they are determined. This is followed by chapters on identification of the essential and accessory minerals of igneous rocks; and by chapters on the "igneous type rocks" and of varietal rocks related to the type rocks; a brief synopsis of a method of describing rocks; and an outline of the quantitative classification of igneous rocks, with numerous examples of the method of calculation of the norm, with numerical tables to facilitate the calculation. There are also tabulated statements of the physical characteristics of the chief rock minerals.

The book is well gotten up and is to be commended for its author's appreciation of the value of quantitative methods of determination and description, and for his simple and direct manner of describing the ordinary method of procedure in the customary identification of rocks in hand specimens, and of minerals under the microscope.

It is a mistake, however, to call the book an introduction to the more serious study of igneous rocks as set forth in larger treatises on the subject. It would seem to have been prepared for a class of students who did not intend to study the subject thoroughly, a very large and legitimate class who desire only a slight knowledge of the subject. For the work labors under the disadvantage of an attempt to simplify a highly complex subject, and to express in a few words ideas and definitions which require fuller statements and amplification in order to be correct. The attempt has led the author into some errors that he might have avoided. It has emphasized the idea of rock types, which will lead students to expect what they will not find in nature, and it has given false ideas as to the composition of rocks having the commonest names. The author himself remarks that the concise statement made in the table of igneous rocks on page 98 may readily be misinterpreted by the beginner. Why then make it? It certainly conveys the impression that andesites are characterized by mica and amphibole, and that

[2] See Rettger, SCIENCE, January 23, 1914, p. 140.

pyroxene is subordinate. One who is not a beginner knows that most andesites contain more pyroxene than mica or amphibole; and in many instances pyroxene without either mica or amphibole. The impression is also given that granite does not contain lime-soda-feldspar. There are numerous inaccuracies of statement and definition that might be pointed out, which may be charged to the attempt at simplification. It does not seem desirable that students who intend studying petrology thoroughly should begin by studying it in an inadequate manner, and experience the necessity of remodeling some of their fundamental concepts.

JOSEPH P. IDDINGS

An Introduction to the History of Medicine, with Medical Chronology, Bibliographic Data and Test Questions. By FIELDING H. GARRISON, A.B., M.D. Philadelphia, W. B. Saunders Co. 1913.

The reproach that has been brought against modern science to the effect that it looks only to the present and future and gives little consideration to the past, probably finds the least amount of justification in the case of the medical sciences, if one may judge from the rapid increase within recent years in the amount of literature, both periodical and monographic, that deals with the history of these sciences. But it has been to France, and more especially to Germany, that we have been principally indebted for compendious treatises on the history of medicine, the only works of that nature written within recent years by English-speaking authors being the brief "Epitome" of Dr. Roswell Park and the delightful "History of Physiology" by Sir Michael Foster. The publication of the work before us is, therefore, an event of no little interest, since it places in the hands of English readers a reliable, comprehensive and interesting account of the development of medical theory and practise, from the earliest times down even to the present day. It is noteworthy also in that its production has been made possible by the unequalled collection of works dealing with the history of medicine that has been brought together in the library of the surgeon-general at Washington. Dr. Garrison is to be heartily congratulated upon the excellent use he has made of it.

The book opens with an introductory chapter on the identity of all forms of ancient and primitive medicine, and then follow chapters on Egyptian, Sumerian and Oriental, Greek (under which are included the Alexandrian and Roman schools), Byzantine, Mohammedan and Jewish, and medieval medicine, all these being treated in the brief space of one hundred and thirty pages. Then follows a well-balanced chapter on the period of the Renaissance, but the greater part of the book, nearly five hundred pages out of six hundred and sixty odd, is devoted to the history of the sixteenth to the twentieth centuries, the chapter on the twentieth century giving a welcome review of the development of our knowledge of such subjects as the internal secretions, the synthesis of proteins, parasitology, chemo- and sero-therapy.

Each chapter consists of a biographic and a general portion, the former setting forth the main features of the lives, endeavors and accomplishments of those who have contributed in any degree to the advancement of medicine, while the latter sums up succinctly and clearly the conditions under which they lived and worked. As appendices there are added a useful medical chronology, a bibliography and a number of test questions, many of which suggest interesting topics for further study and investigation. Finally, mention should be made of the excellent indexes, one of persons and another of subjects, both of which appear to be entirely satisfactory.

Dr. Garrison's book forms a trustworthy reference for those who are interested in any phase of the development of medicine. No name worthy of mention, unless it be that of Dodoens, seems to have been omitted, and although the treatment is fundamentally biographic, the subject index makes it easy to ascertain the essential events in the development of special departments of medicine. And yet with all this thoroughness in so small

a compass, the book is far from being a mere catalogue of names, facts and dates. The author's style gives life to his descriptions; he has the happy faculty of seizing upon the salient points of his subject and vivifying them by allusion, comparison and quotation. Interest, too, in the text is greatly increased by the large number of portraits with which it is illustrated, a feature that especially distinguishes the book in comparison with its predecessors.

In covering so vast a field errors are almost unavoidable; nevertheless the number to be noted in Dr. Garrison's book is so small that it seems almost invidious even to mention them. It hardly seems just, however, to speak (p. 78) of Galen as "little of an anatomist." Surely the writing of such a treatise as the "De Anatomicis administrationibus" in the second century marks its maker as one of the greatest of anatomists! The title of Averroes' great work (p. 89) is not "Ketab," but rather "El-Kollijat," of which the word "Colliget" is merely a transliteration. Mention should surely have been made (p. 149) of the splendid "Quaderni d'Anatomia" of Leonardo, at present being edited by Dr. Hopstock and his colleagues. The discovery of the pancreatic duct by Wirsung (p. 180) was made in the dissecting room of Vesling and not in that of Vesalius. The statement (p. 602) that "twins always have the same sex" is manifestly in need of correction. There are also a few obvious minor slips, and one must regret the omission from the bibliographic appendix of such works as the excellent Vorlesungen of Professor Ernst Schwalbe, Le Clerc's "Histoire de la Medicine Arabe," Lauth's "Histoire de l'Anatomie" and Medici's interesting "Compendio storico della Scuola Anatomica di Bologna."

But such errors and omissions are of little account beside the general excellence of the work. Its thoroughness, conciseness and clearness bespeak for it the fullest appreciation from all who are interested in the past and future of medicine.

J. P. McM.

Stammering and Cognate Defects of Speech. By C. S. BLUEMEL. 2 vols. New York, Stechert and Company. 1913.

The first volume is called "The Psychology of Stammering" and the second reviews critically many of the current systems for the treatment of speech defects. The first hundred pages of Volume I. are employed in a popular exposition of such psychological facts and opinions as the author may later need in his description of the etiology of stammering. The chapter headed "The Brain" deals rather dogmatically with some of the mooted questions of cortical localization and lacks many references to original sources. The chapter on aphasia is well handled and serves as an excellent introduction to the author's thesis that "the stammerer's difficulty is transient auditory amnesia" (p. 187). It is well shown that this amnesia attaches to the vowel sounds, especially to the more obscure ones, and that it is characteristic of the audito-moteur rather than of the subject possessing predominantly the visual type of imagery. We have already (pp. 98 and 103) been prepared for this position by the foregoing discussion concerning the necessary incitation for voluntary speech. This, it is held, always involves kinesthetic imagery, auditory imagery being supplementary and functioning chiefly in vowel production. Consonant production may be actuated by kinesthetic imagery alone, but not so the formation of the short and relatively "colorless" voice sounds. When the auditory imagery is temporarily lost or weakened the more obscure vowel sounds become impossible of production and stammering results. This position is strengthened both by introspection and by the records of speech cases, and if correct is of the utmost value in indicating the appropriate treatment for stammering.

Volume II. includes an excellent account of current systems of training, treated under the chapter titles: Respiration, Vocalization, Articulation, Verbal Exercises, Mechanical Appliances and Psychological Methods.

STEVENSON SMITH

SPECIAL ARTICLES

TILTED SHORELINES OF ANCIENT CRAIGTON LAKE, OHIO [1]

Description.—A lake bed mentioned by Read,[2] by the present author[3] and by Dachnowski[4] lies in a mature, branched, preglacial, north and south, valley west of Wooster and east of Ashland, Ohio. The lake which occupied this bed shortly after the ice withdrew is called Craigton Lake. It may be said to center near Funk, Ashland county, and to extend in three arms, southward seven miles, northward about eleven miles and northwestward twelve miles. The main north-south axis is a little more than eighteen miles long.

That such a lake[5] really existed is abundantly attested by beaches, cliffs, deltas, water-modified moraines and extensive flats of lake clays.

A cursory examination of the features in 1912 suggested that the beaches were not now horizontal and during the past summer careful instrumental leveling starting from U. S. Geological Survey bench marks has been done at several points along the lake plain. By this means it was found that the beach lines are far from horizontal.

The delta surfaces at the northern end are 1,040 feet above sea level. Some little wave work can be seen higher. Three miles and a half southward the beaches are at about 1,020. The altitude of 1,000–998 was found about a mile north of Funk. At Craigton the beach is 973 feet high and at the southern end we found it to be 960 feet with no wave work higher. Allowing 5 feet for possible fans or outwash deposits on the delta at the upper end, where the proper level on which to read is extremely difficult to determine, we still have 1,035 here and a difference of 75 feet in 18 miles, the southern end being lower by this amount. This means a tilting upward relatively at the north with reference to the south end of about 4 feet in a mile.

Interpretations and Correlations.—The postglacial tilting of the shorelines of the precursors of our Great Lakes has long been recognized. Very little evidence has been found of tilting south of the borders of our present lakes. The long east-and-west abandoned beaches across Ohio show almost no tilting, but lines running more nearly north and south are appreciably displaced. The evidence presented above carries actual tilting 50 miles south of the most southern part of Lake Erie, itself the most southern lake. Furthermore the rate of tilting is greater in this case than that observed on many of the abandoned beaches further north.

Goldthwait[6] who has worked extensively on abandoned beaches to establish the amount and kind of warping that may have taken place, shows that the Algonquin beach is not tilted south of a line through the middle of Lake Michigan and Niagara Falls. In the same paper he shows that the older Iroquois beaches are tilted more than the Algonquin in the same latitudes and that the tilting extends farther southward for the Iroquois beach. He shows that the tilting is greatest further north and decreases southward, but he is unable to locate any southern limit for the tilting.

That the existence of Craigton Lake began earlier than that of any of those preceding even Lake Erie is easy to believe because of its location with reference to the retreating ice. Its site would be uncovered even before that of Lake Maumee. That tilting in the lake region began early is also shown by the fact that Craigton Lake shorelines are tilted more than such beaches as those of the Algonquin and Iroquois water planes. The warping in Craigton Lake lines amounts to four feet in a mile and is quite uniform for the 18 miles of length. It may be a little steeper in the last two or three miles at the north end

[1] Summary of a paper presented before the Ohio Academy of Science, at Oberlin, O., November 29, 1913, and published by permission of the state geologist.

[2] M. C. Read, Geol. Surv. Ohio, 1878, Vol. III., pp. 519–529.

[3] Geo. D. Hubbard, *Am. Jour. Sci.*, 1908, Ser. 4, Vol. XXV., pp. 239–43.

[4] A. Dachnowski, Geol. Surv. Ohio, 1912, Ser. 4, Bull. 16, p. 134.

[5] Full description of this evidence with maps and section will appear in *Amer. Jour. Sci.* soon.

[6] J. W. Goldthwait, G. S. A. Bull., Vol. 21 (1910), pp. 227–248.

but probably is not. The apparent increase in rate is more likely due to aggradation with glacial outwash or to the building of a fan on the delta at the northern end.

Craigton not only began, but probably completed its history as a lake before the tilting occurred; a considerable part of its tilting must have occurred before the Iroquois beaches were tilted and all of it before the Algonquin was tilted, because in the first place its tilting is greater than that of the Iroquois; and in the second, Algonquin tilting did not proceed so far south. Had water remained in Craigton during the tilting, it must have spilled over southward. There can be found no evidence of static water work on the hills above the recorded beach levels at the southern end. If water stood higher here, then many tracts, low between moraine hills but higher than 960 feet, should have been under water and should attest that fact by sorted drift, lake clays, and possibly by black earth deposits of palustrial origin. Nothing of the sort can be found.

Because the outlet was in the middle portion of the lake the southern part would not be drained by the tilting. Drainage possibly fairly well established would be interfered with; swampy conditions would develop and will persist until more perfect drainage is attained. Black, peaty earth, very abundant in the southern part, confirms the belief that this end of the lake was long swampy. In fact artificial ditching has but recently put it into agricultural condition. Hundreds of acres of onions are now grown on the black flats that are sufficiently drained. Water does not stand anywhere on the plain but swampy conditions are not entirely removed.

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II

COMPARATIVE PHYSIOLOGY

The Reactions of Normal and Eyeless Amphibian Larvæ to Light: HENRY LAURENS.

Although the photic reactions of Amphibians have been extensively investigated very little has been done on the larval forms. The purpose of the present investigation was to test the reactions to white light of normal and eyeless frog (*R. pipiens* and *R. sylvatica*) and *Amblystoma* (*A. punctatum*) larvæ. The optic vesicles were removed from the blinded individuals at a stage of development soon after the closure of the neural folds, when the tail bud is just beginning to be perceptible. Frog larvæ, both normal and blinded, show no reaction to the stimulus of light. Both normal and eyeless *Amblystoma* larvæ, however, show a very decided positive phototaxis. The reactions of the blinded individuals are apparently not due to the direct stimulation of the central nervous system by the light as is shown by a series of experiments in which three small areas of the larvæ were illuminated, these areas being roughly the head-region, the ventro-lateral mid-body region, and the tail-region. Positive responses were obtained when each of these regions were illuminated by a narrow beam of light, the percentage of positive responses being practically the same in each case. The skin chromatophores of *Amblystoma* larvæ show different conditions of expansion and contraction of their pigment under different conditions of light and darkness; the conditions in the normal and blinded larvæ being exactly opposite. Normal larvæ placed in diffuse light are pale (light brown), blinded larvæ so placed are very dark. Normal larvæ placed in darkness are darkly pigmented (dark brown), while blinded larvæ so placed are very pale. But normal larvæ placed in diffuse light on a black background are darkly pigmented, thereby showing the effect of the background. These different conditions of the pigment in the skin chromatophores do not affect the sensitiveness of the larvæ to light, but previous exposure to light or adaptation to darkness do, in that dark-adapted larvæ are more sensitive to light than are those which have been kept in the light.

An Analysis of the Egg Extractives of Arbacia and Asterias: OTTO C. GLASER.

Analyses (1) by means of sperm-suspensions; (2) by means of qualitative chemical tests; (3) by means of the rate of development, were made. The results briefly summarized, are:

1. A general corroboration of F. R. Lillie's observations with respect to *Arbacia punctulata;* their extension in certain directions, and their application to *Asterias forbesii.* Hetero-agglutination and hetero-activation between *Asterias* and *Arbacia* were found. Agglutination is very likely the result of a surface effect.

2. Proteins, if present at all, do not necessarily come from the eggs, and are extremely dilute. Reducing substances seem to be absent. The agglutinin is heat-resistant. A purple compound, apparently specific for *Arbacia*, is formed when the sperm, the eggs or the agglutinin itself undergo certain changes. More soluble substances are secreted at the moment of fertilization than before. This, together with the fact that the volume of the eggs is smaller after fertilization, constitutes new and strong evidence in favor of the contention that fertilization involves an increase in permeability. From this it need not follow that fertilized eggs are more permeable than unfertilized. In fact this is not very probable.

3. Egg-secretion as well as egg-extract, in certain concentrations, retards development. NaOH in certain concentrations does not accelerate cleavage, but may even depress it. In the same concentrations, it accelerates the development from the blastula to the pluteus. Egg-secretion + NaOH in the above concentrations retards the cleavages much more than either used separately. One can draw no inference from these experiments as to how the egg-secretion acts in retarding development.

The suggestion that development is initiated as the result of a disturbance in equilibrium in which substances antagonistic to oxidation are eliminated is possible. It is equally possible that the removal of the substances lost allows other equally important processes to be set up. The initiation of development is identical with the initiation of cell division. For this process fertilization, even if it involves all that Lillie's theory includes, can not be considered essential, since somatic cells divide without it. This does not imply that the mechanism of fertilization may not be exactly as F. R. Lillie supposes, but the possibility that the initiation of cell division depends on other processes which also occur at the moment of fertilization remains. Neither these suggestions nor the facts on which they are based appear to the author out of harmony with existing theories. A full discussion will be published in a forthcoming issue of the *Biological Bulletin*.

Feeding Habits of Amœba: Asa A. Schaeffer.

The method of investigation is very simple. A very small particle of the substance to be tested was placed in the amœba's path by a very finely drawn out glass needle. Camera lucida drawings were then made at frequent intervals in order to record the behavior accurately. A large number of substances were used: small animals and plants, isolated proteins, carbohydrates, fats, carbon, glass, carmine, etc.; also capillary tubes filled with solutions of various substances.

It was found that the amœba exercises a considerable degree of precision in selection while feeding; objects of food value being eaten while those valueless as food were rejected. However, of the substances eaten, carmine, india ink and uric acid are probably valueless as food; and of the substances refused, casein, gelatin, lecithin and zein are food substances. What the basis is upon which amœba selects its food can not be stated. But amœba eats everything that moves. If a particle of carbon or of glass or other substance is properly agitated by means of a glass needle, such particle will be eaten.

Amœbas react to objects at a distance, whether soluble or insoluble. The maximum distance through which an amœba may sense an insoluble object 20 microns in diameter is from 40 to 60 microns.

Some amœba may be *led* about by "tickling" with an extremely fine glass needle. A typical "food cup" may also be produced in this way.

The behavior of amœba while feeding is subject to very great variation.

Changes in Pattern and Color in Fishes, With Special Reference to Flounders: S. O. Mast.

Abstract in Science, Vol. XXXVIII., page 699.

The Reactions of the Orb-weaving Spider, Aranea Cavatica; to Rhythmic Vibrations of the Web: W. M. Barrows. (Illustrated with lantern slides.)

It was found by using vibrating tuning forks and an electric vibrator that when one part of the spider's web is set in rhythmic motion (24–100 vibrations per second amplitude 3–12 mm.) the spider orients, advances rapidly toward the vibrating point, and attacks the vibrating instrument, even biting and throwing web on it. This positive reaction was not obtained when irregular vibrations were used as the stimulus. When a double or Y-shaped vibrator was used the spider oriented and advanced directly between the two vibrating points. The author considers this response a typical tropism and suggests the name "tonotaxis" to designate it.

Secretion in the Protozoan, Folliculina: E. A. Andrews.

This specialized *Stentor* secretes a transparent case of green or brown color, resembling a stocking in form. The rounded foot has one flat side

firmly fastened to some solid, the long leg rises up 45 to 90 degrees from the sole and bears on its outside a spiral ridge of six or more turns, while its mouth is completed by a reflexed lip. Three factors enter into the making of this case: the coordinated contractions of the body; the behavior of the cilia; a special secretion. The first factor determines the form of the case, which is then a permanent record of the secretory "instincts" of the animal. The animal first assumes the shape of the future foot of the case and secretes this about itself. Then by a special set of contractions of the anterior part it forms a mould upon which the spiral tube is made, turn by turn, with the measured elongation of the rest of the body. Finally, by an entirely unexpected change in form of the mould the lip of the mouth is added. The only part of the animal in contact with the case is the point of permanent attachment to the bottom of the case, elsewhere the secretion is laid down as a hardening mass separated from the body by the length of the cilia. As the secreting progresses from the foot up the cilia pass through successive states, at first rigid and quiet, then specially active in limiting the inner face of the case wall.

In the posterior end is a special organ, some 10 by 20 microns in diameter, associated with the myonemes.

In response to contact with solids of some kinds the posterior end puts out an adhesive secretion that, apparently mechanically, influences other *Folliculinas*, so that from the free-swimming state they commonly settle down in colonies, each with its separate case, but all fast to a common pellicle spread over the solid object or even over the surface film of quiet water.

The case is secreted when the specialized frontal field and lobes are not yet present.

The Reactions to Light and Darkness of the Melanophores of Frog Tadpoles: DAVENPORT HOOKER.

The tadpoles of *Rana pipiens* were used as subjects for investigation and some seventy-five series of experiments were performed. Each series extended over a number of days and each tadpole was subjected to a variety of conditions. The light used in the experiments was either direct sunlight or the light of a 75-candle-power Welsbach mantle. To obtain total darkness, the tadpoles were placed in blackened light-tight boxes or in an unilluminated dark room.

The following results were obtained:

1. The melanophores in the subepidermal layer of connective tissue of tadpoles respond to light and darkness in the opposite manner from those in the corium of adult frogs, with which they are identical. The former expand in response to light and contract in response to dark.

2. The epidermal melanophores do not respond.

3. The color of the background has no effect on the nature of the response in tadpoles.

4. The transition from the larval to the adult type of response takes place after metamorphosis.

5. Continued exposure to darkness produces a secondary reaction of expansion of the melanophores in the tadpole. This follows the primary reaction of contraction by an average of six hours.

6. To again obtain contraction of such expanded melanophores, the tadpole must be exposed to light.

The Movements of the Dog-fish as Determined by Olfactory Stimulation: G. H. PARKER.

A normal dog-fish, when confined in a large pool, swims more or less continuously back and forth, turning at the ends of its course. When excited by food, it courses over the bottom of the pool, turning now to the right, now to the left. This form of locomotion does not occur when the nostrils are occluded with cotton. Hence the food excitation is an olfactory response (Sheldon). When excited by food, a normal fish turns about as often to the left as to the right and generally exhibits a course like a figure eight. When only the left nostril is occluded, the fish turns predominately to the right; when the right nostril is plugged, predominately to the left. In each case the predominating turns may be as many as 90 per cent. of the total turns. These observations lead to the conclusion that, in seeking food, the dog-fish commonly turns toward the more vigorously stimulated nasal organ.

The Oxygen Utilization of Fishes: G. G. SCOTT.

Internal Pressure in Sponges: G. H. PARKER.

The internal pressure under which the current of water flows through a sponge was measured hydrostatically and found to vary in eight species of marine sponges from one to four millimeters of water. In *Spinosella sororia* an average finger discharges under a pressure of about three millimeters of water 78 liters of water a day. A colony of twenty such fingers would discharge about 1,575 liters a day, or over 415 gallons. Sponges move large volumes of water at very low pressure.

A Study of the So-called Life Cycle in Oxytricha fallax and Pleurotricha lanceolata: GEORGE A. BAITSELL.

Further Light on the Conjugation of Paramœcium: L. L. Woodruff.

This paper will appear in the *Jour. Exper. Zoology,* February, 1914.

Reactions of Amœba to Light: Asa A. Schaeffer.

Perpendicular beams of white and of monochromatic spectral light about 20 microns in diameter were projected through the microscope after being passed through 20 centimeters of water. The beams were projected in or near the paths of amœbas.

The amœbas reacted to these beams of light before they came into contact with them as seen by the human eye. In nearly all cases the reaction was positive, that is, the amœba moved toward the beam of light. There was very little, if any, difference observed in the reactions toward beams of white and of the various spectral monochromatic lights.

Brightly illuminated food particles were eaten neither more nor less readily than when illuminated evenly with the field; but when very slightly illuminated, that is, when laid on a "dark spot," the food object was sometimes not eaten.

Amœbas frequently move toward a beam of light in a curved path, finally coming into contact with it; occasionally the curved path extends around the beam of light so that the amœba encircles the beam for a greater or less distance without coming into contact with it. If an amœba has oriented itself with respect to a beam of light, the beam may then be extinguished without causing a change in the direction of movement. Such continuance of the direction of movement after an orienting stimulus is removed is due to "functional inertia," by virtue of which in this case the amœba tends to keep on moving in a certain direction after it is once started. No external stimuli are necessary for continuing in a straight path. The encircling of objects and of beams of light seems to be due to a balance between a tendency to keep on moving in the original direction (functional inertia) and a tendency to react positively to the stimulating object.

The Olfactory Sense of the Honey Bee: Norman Eugene McIndoo. (Introduced by E. F. Phillips.)

The Feeding Habits of Amblystoma Larvæ: H. S. Burr. (Introduced by R. G. Harrison.)

Normal *Amblystoma* larvæ use the visual sense in obtaining food when it is abundant. When the food becomes scarce the larvæ move slowly about in search of it, nosing in the débris at the bottom of the aquarium. This characteristic reaction suggests the use of the olfactory sense.

Experimental evidence was sought to determine how great was the reliance on this sense. Normal larvæ were tested with bits of motionless beef, sand and live but motionless Daphnids. These tests resulted positively—that is they snapped at the source of the stimulus—in 91.6 per cent. of the Daphnid tests and 38.7 per cent. of the sand tests. The reactions to the beef were comparable to those of the Daphnids.

From eight 5–6 mm. larvæ the nasal placodes were removed under a binocular microscope with the aid of a pair of iridectomy scissors. When they had begun to feed, they were tested by the same methods as were the normal larvæ. No reactions to beef or motionless Daphnids were obtained. To sand they reacted positively in 60.7 per cent. of the tests.

From eight 4–5 mm. larvæ the optic vesicles were removed. These were loaned to the writer by Dr. Henry Laurens. These were tested with motionless Daphnids. They reacted positively in 98.8 per cent. of the tests.

In the sand tests, the normal larvæ as they grew older showed an adaptation, in that the percentage of positive reactions was greatly reduced in the tests of the older individuals. The noseless individuals showed no such adaptation.

Hence we may conclude that the larval *Amblystoma,* while using the visual sense in obtaining food when it is abundant, may in the absence of moving food make use of the sense of smell, and that this sense is of increasing importance to the animal as it grows older.

Experimental Analysis of Certain Processes in the Food Vacuole of Bursaria: E. J. Lund. (Introduced by H. S. Jennings.)

ECOLOGY

The Life History of the Bullfrog (Rana Catesbeiana): Albert H. Wright. (Illustrated with lantern slides.)

Because of its size, appetite, vocal accomplishment and shyness, this species has received more attention than any other American member of the genus *Rana.* It frequents marshy bayous, buttonbush swamps, mill ponds, reservoirs, glacial or sphagnaceous lakes and some marshy streams. In first appearance this species is most influenced by water temperatures. When the air reaches 68–75 (certainly 76–79), we may expect the appearance of the bullfrog, provided the water bottoms are

57–64 or average 64–69. The average date of appearance is May 20, the earliest date May 11. At the mating season the first finger of the male becomes enlarged. The type of amplexation is axillary. The breeding season extends from June 15–August 1, the average date of beginning of ovulation being June 30. The female keeps in one position more or less and lays a pancakelike film of eggs on the surface of the water. This film may be from one foot to three feet in diameter. The eggs are laid among brush, driftwood, old stumps in water, etc. During ovulation the prevailing air temperatures are from 71–80; the water maxima from 66–71. It takes only a few minutes to lay the 12,000–20,000 eggs. The jelly is loose, the animal pole black, the vegetative pole white. There is no evident middle envelope. The eggs usually hatch in 5–3 days because usually subjected to a temperature of 65–80. The tadpoles require two or more years of growth before transformation. The relative smallness of the eggs (vitelli 1.2–1.7 mm. in diameter), the late deposition of the eggs, and the greater transformation size required (53 mm. instead of the 9.6 mm. of two or more winters in the larval stage. Besides the toad)—all combine to make this form spend other characters, the best external character is the tail with regular round black spots, some of which are dumb-bell-like in shape. The belly is straw- or maize-yellow, not iridescent. Transformation comes from July 18 to August 15 or months later.

An Experimental Study of the Behavior Agreement of the Animals of an Aquatic Community: V. E. SHELFORD.

The Relation Between Rheotaxis and Resistance to Potassium Cyanide in Isopoda: W. C. ALLEE.

The cyanide-resistance method which Professor Child worked out as a measure for the metabolic rate of planarians also holds for isopods. This is demonstrated by the effects of changes in temperature and mechanical stimulation upon the survival time in potassium cyanide; also by tests with young and old isopods, and by comparing the survival time and carbodioxide output in the same individuals. Average results from experiments on 452 isopods show that animals giving a highly positive rheotactic response have the highest rate of metabolism. Those giving a highly negative reaction are next, while isopods giving a low positive and high negative or indefinite response have a still lower metabolic rate. Isopods with a high efficiency of movement in the current have a higher rate of metabolism than those with low efficiency. These results support previous work on this subject.

MISCELLANEOUS SUBJECTS

The Reaction of the Honey Bee to Changes in External Temperature: E. F. PHILLIPS AND GEORGE S. DEMUTH.

The Organs of Special Sense of Prorhyncus: WILLIAM H. KEPNER AND WILLIAM H. TALIAFERRO.

The organs of special sense of this rhabdocele are the eyes and the ciliated pits. The two eyes lie beneath the epidermis, within the mesenchyme in depressions at the dorsal surface of the ganglia. The two ciliated pits open on the ventral side of the body anterior to the anterior limits of the surfaces of the ganglia and midway between the lateral surfaces of these cell masses and the margin of the body.

One of the unique features of these four organs is that they are formed of a definite number of cells. There are only eighteen cells involved in the formation of the four organs of special sense of *Prorhyncus.*

Each eye consists of two cells—an accessory or pigmented cell and a retinular or visual cell. The pigmented cell appears to be a modified mesenchymal cell. Its mesial cytoplasm resembles that of the typical mesenchymal cell. The lateral part of its cytoplasm, however, has assumed a definite, cup-like contour. This part of the cytoplasm, in its fixed condition, presents concentric lamellæ with which the pigment of the cell is associated. The mouth of this cup is directed laterally.

The retinular cell appears to be a modified nerve-element. Its nucleus has the characteristic spheroidal contour of a nerve-cell. In the cytoplasm, in its fixed condition, there are three regions. The lateral region is a finely granular cone that lies closely applied to the dorsal surface of the ganglion. The lateral end of this cone, we infer, is continued as a nerve-fiber into the ganglion. The basal or mesial fourth of this cytoplasmic region accommodates the nucleus. The middle cytoplasmic region of the retinular cell is the densest region. It is a concavo-convex disc. We are not prepared to say that this lens-shaped region of cytoplasm acts as a lens for converging the rays of light upon the pigment cell and rhabdome. We shall be content to look upon it as the supporting structure of the mesial cytoplasmic region, which is the rhabdome of the visual cell. The rhabdome is a low sugar loaf-shaped body that fills the cup of the pigmented cell.

The ciliated pits are invaginated regions of the

ventral epidermis, which are directed obliquely posteriorly and mesially. In the structure of each pit seven cells are involved. Six of these cells form a sensory syncytial lining or wall of the pit. These six cells are recognized by their nuclei, three of which form a dorso-ventral row in the lateral wall of the pit and three a similar row in the mesial wall. Stout cilia are borne by the general surface of the syncytial wall. This suffices for the prevalent conception of the structure of the ciliated pits of flatworms. But all of the surface of the wall of the pit does not bear cilia. Just over the middle nucleus of each side there is a well-differentiated sensory rod, so that we may look upon the wall of the pit as being formed by four accessory cells and two sensory cells. A special nerve from the ganglion runs to the posterior dorsal part of the sensory cells of each pit. The seventh cell of the pit is a large gland-cell, which crowns the widened base of the pit. The contour of this gland-cell is quite as indefinite as that of the unicellular glands of the general epidermis. Its secretion granules, however, can be differentiated from the secretion granules of the general epithelial glands by the use of Bordeau red. This unicellular gland opens by pores through the wall of the pit at the anterior angle of the fundus.

Therefore, as we have shown in *Microstoma caudatum*, the ciliated pit is not a simple highly ciliated structure, but it is differentiated into a ciliated, sensory region and a glandular region. Thus the inferred affinity between the *Platyhelminthes* and the *Nemertine* is strengthened by the close resemblance between the structure of the ciliated pit of the former to that of the simpler cerebral organs of the latter.

The Experimental Modifications of Tiger Beetle Color Patterns by Variation of Temperature and Moisture During Ontogeny: V. E. Shelford.

Some Experiments on Regeneration in Thinodrilus limosus: Mary T. Harman.

Both the anterior and posterior regeneration has been considered. At the anterior end of any piece the maximum number of segments regenerated is six plus the prostomium. The first external indication of differentiation is the differentiation of the prostomium followed closely by the first segment. After that the segment adjacent to the old part of the worm is differentiated from the newly regenerated portion and then the segments are differentiated from the base toward the tip in regular order. Although six segments plus the prostomium are the maximum number of segments regenerated, the size of the regenerated portion and the rate of regeneration varies with the level of the cut and is independent of the size of the regenerating piece and the amount of injury.

There is, also, a region of maximum rate of posterior regeneration and this is independent of the size of the regenerating piece and the degree of injury. The amount of posterior regeneration increases rather suddenly from the head to the region of maximum rate of regeneration and then decreases more gradually toward the tail region. Pieces taken from the most posterior part of the worms do not live long and seldom show any regeneration. The direction of differentiation in the posterior regenerated part is from the base outward. However, the anal opening is soon formed. During regeneration a part of the most posterior portion of the regenerated tail remains unsegmented as a sort of segmental plate.

Will an Earthworm Regenerate Anterior Segments When the Enteric Epithelium is Absent From the Cut Surface?: H. W. Rand and H. R. Hunt.

The Fly, Œstrus Ovis, Parasitic in Man: H. F. Perkins.

More than a hundred living larvæ were discharged from a lung abscess in pus and mucus by a boy ill for several months. These small larvæ were identified as the early stage of the sheep bot *Œstrus ovis* and this determination has been corroborated by the Bureau of Entomology. Infection was by the mouth, the fly and the larvæ seeming to be attracted by the purulent discharges.

No case seems to have been recorded of an insect parasitic in the lung of man or any other mammal, and *Œ. ovis*, while it has been found in the frontal sinuses and rarely in the eyes and throat walls of man in Algeria, has only once or twice been found in man in America. The species is not uncommon in the region where this boy lives, and he took care of sheep for three years previous to his illness.

The larvæ were probably living in the abscess for at least three months, but none of them developed beyond the third stage, whereas normally they would in the same time have developed into flattened grubs of ten times the bulk, this retarded growth being attributable to the lack of oxygen in the non-functional lung.

The Effect of Alcohol on the Male Germ Cells, Studied by Means of Double Matings: L. J. Cole and C. L. Davis.

Recent work has amply demonstrated that offspring from alcoholized males are commonly defective to greater or less degree, even though the mother has not received treatment and is presumably normal. Stockard's experiments with guinea-pigs have been especially conclusive, and he has furthermore shown that the effects of the treatment may persist to the second generation of offspring.

The present experiments were undertaken to test this matter with rabbits, and to take advantage of the complete control possible in double matings, that is the mating of a single female to two males at the same period, and the consequent production of offspring from both fathers in a single litter. By breeding a male homozygous for color and an albino male both to an albino female it is possible to assign the young to their respective fathers, since the offspring of the colored male will be colored and those of the albino male will be albinos. If one of the males now be alcoholized while the other is normal, and offspring from both result, any differences, such as defects in the offspring, may safely be attributed to the effects of the alcoholizing of the male, since both sets of fetuses have developed in the same uterus at the same time, and consequently there can be no question of different environmental influences.

As a preliminary test 36 double matings were made in which both males were normal. Of these, 12, or 33⅓ per cent., were successful; that is, young were obtained from both fathers. An inspection of the 24 matings in which the two normal males were used, but in which all the resulting offspring were from one father, shows that the individuality of the male is of more importance than the order in which they are mated to the female. Thus one pigmented male (14.1), before he was alcoholized, was used in 23 matings, an albino male being used also in each case, with the following result:

In 15 litters all the young were from 14.1, although he gave first service in only 6 cases, and followed the albino male in 9 cases.

In 8 litters young were produced from both males. 14.1 gave first service in 3 cases, and was second in 5 cases. Of the 62 offspring produced, 14.1 was the father of 38, and the albino male of 24.

So while as a result of the whole 23 matings there were 190 offspring produced, the albino male sired only 24 of them.

These facts appear to establish a strong individual potency for 14.1. On the other hand, after he had been alcoholized (by the inhalation method), *he failed to sire any offspring at all* when used in conjunction with an albino male, although he was bred to the female first in at least 5 of the 7 matings made. But when he alone was bred to normal females, he sired several litters of young that appeared to be normal. There have since, however, appeared certain signs which may be indications of defects among these offspring.

Summary: There appear to be differences in the "potency" of the spermatozoa of different male rabbits. (This may be due to differential "vitality," expressed as greater or less motility, penetrating power or something of the sort.) Treating a male to the fumes of alcohol quickly lowers this "potency." Litters were born to alcoholized males (when used alone), but there are some indications of defects in the offspring.

Some Negative Results Obtained From Experiments With Fowl Tapeworms: JOHN W. SCOTT.

Ransom in 1909 mentions that we do not know the full life-history of any of the tape-worms found in American poultry. The following experiments were made in an attempt to find the intermediate host of two of three forms, *Hymenolepis carioca* and *Davainea tetragona*. A barnyard was located in which most of the fowls were infected with one or both of these parasites. A number of chicks as soon as hatched were placed in a large screened cage and kept there until the end of the experiment. (1) To one lot of these chicks two species (not determined) of *Menopon* were fed, the lice being collected in large numbers from no less than eighteen old and young fowls in the barnyard. The idea was that, since some of the lice are usually found feeding upon the skin and soiled feathers in the anal region, the fowl might easily swallow some of them while preening its feathers. (2) Within easy access, where the fowls spent much time in scratching out "wallows" around a dung heap, were small annelids (*Helodrilus parvus*). A large number of these were fed to a second lot of chicks. (3) House flies, hatched from pupæ in a screened cage, were exposed to ripe proglottids and to feces taken from the intestines of infected fowls; on following days they were fed to a third group of chicks. Not a single tapeworm was found in any of the chicks when killed, nor in the controls. These results are reported since they appear to be conclusively negative.

Hermaphroditism in the Brook Lamprey: Peter Okkelberg. (Introduced by R. W. Hegner.)

In a study of the reproductive organs of the American brook lamprey, *Entosphenus wilderi*, it was found that a juvenile hermaphroditic condition occurs normally and that there were three kinds of individuals as regards sex, namely, true females, true males and hermaphrodites.

The sex glands of fifty larvæ, ranging from 7½ cm. to 20 cm. were studied and it was found that 46 per cent. were true females, 10 per cent. were true males and 44 per cent. hermaphrodites. In the adult condition males and females occur in practically equal numbers and the conclusion is reached that all the hermaphrodites develop into males. Out of 15 male specimens examined seven were found which contained undeveloped ova, —some a few and others a great number. These ova were similar in structure and size to those found in the larvæ.

The number of ova found in the mixed gland varied greatly. Sometimes only a single ovum was found and in other cases a large number of ova were present.

The hermaphroditic condition in the lamprey seems to be similar to that found in several of the other lower vertebrates such as *Myxine*, some Teleosts, and in some Amphibians.

EXHIBITS

During the meetings the following exhibits were made by members of the society in one of the rooms of the Zoological Laboratory of the University of Pennsylvania.

E. P. Phillips and George S. Muth (Bureau of Entomology)—Instruments (Thermo-electric Outfit) (Special Scale), used in work on Behavior of the Honey Bee.

S. O. Mast (Johns Hopkins University)—Photographs and Autochromes showing changes in color and pattern in flounders.

Robert K. Nabours (Kansas State Agricultural College)—Specimens and charts illustrating "Inheritance in Orthoptera."

M. F. Guyer (University of Wisconsin)—Demonstration of the X-element of Plymouth Rock Fowls.

J. E. Ackert (Kansas Agricultural College)—Demonstration of the Innervation of the Integument of Chiroptera.

H. D. Reed (Cornell University)—Model of the Pectoral and Axillary Glands in Schilbeodes gyrinus.

Caswell Grave,
Secretary

THE ASSOCIATION OF AMERICAN GEOGRAPHERS

The tenth annual meeting of the Association of American Geographers was held at Princeton, January 1 and 2, 1914. About thirty-five members were present and the attendance of members and non-members ranged from twenty-five to sixty. Thirty-six titles appeared on the final program and twenty-eight papers were read.

The officers for 1914 are as follows:

President—Albert Perry Brigham.

First Vice-president—Charles R. Dryer.

Second Vice-president—C. F. Marbut.

Secretary—Isaiah Bowman.

Treasurer—Francois E. Matthes.

Councilors—Lawrence Martin, Robert DeC. Ward, Alfred H. Brooks.

Editor—Richard E. Dodge.

The nominating committee for officers for 1915 consists of C. F. Marbut, chairman, R. H. Whitbeck, H. H. Barrows.

One of the most important features of the meeting was the adoption by the Association of the plan of cooperation proposed by the American Geographical Society. The plan provides for (1) a joint research committee of the two organizations to administer a joint research fund, (2) a joint meeting in New York each spring, (3) the publication by the Association in collaboration with the American Geographical Society of the Annals of the Association, (4) an interchange of the publications of the two societies.

The research committee of the Association consists of: Alfred H. Brooks, chairman, Herbert E. Gregory, Robert DeC. Ward.

An increasingly large proportion of the papers read dealt with various phases of human geography. The first meetings of the Association (1904–1906) were naturally marked by a large number of physiographic papers. Then came a period (1907–1910) when physiography and anthropogeography were alternately ahead. In the last three programs anthropogeography has led, owing chiefly to the growing number of students devoted to the life side of the science. Future programs will probably show a still stronger tendency in this direction, judging by the livelier discussions evoked by the more strictly geographic papers.

The joint meeting in New York will be held April 3–4. The next annual meeting will be held at some point west of Pittsburgh.

Isaiah Bowman,
Secretary